

ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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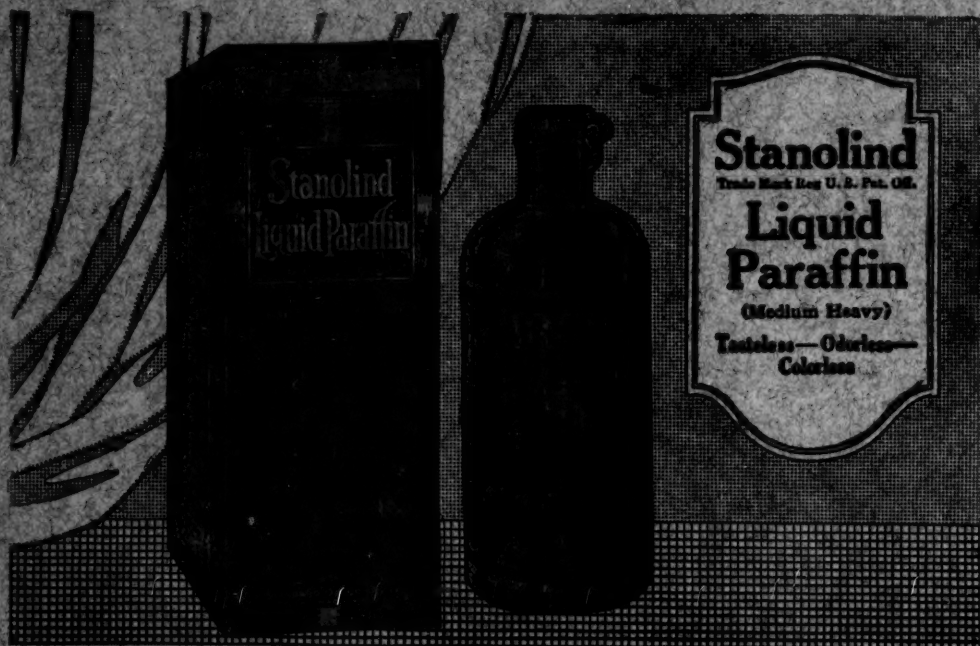
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THE CHOICE OF OPERATIVE PROCEDURE IN CANCER OF THE RECTUM AND PELVIC COLON*

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ONE of the most serious, as well as one of the most interesting, surgical problems is the choice of methods in dealing with cancer of the rectum. It is serious because when unrelieved the disease leads surely to slow death, usually accompanied by much suffering. It is interesting because so many considerations are involved which influence the decision as to whether any operation is indicated either palliative or radical, and if so, what. The first of these considerations is the location of the area involved by the cancer and the forms of the metastases; the second is the extent of the local disease and the associated local or general disease. Obesity increases the risk. The decision as to a palliative or radical operation will be influenced also by freedom from contact dissemination or grafts at a distance within the abdomen.

The intelligent patient usually inquires whether there is any other way of treating the disease than by surgery. If not, he wishes to know the operative risk and the prospects of cure; whether he will retain control of his bowels, and whether the new opening will be behind or in front? Among other methods of treatment, the use of radium is making great strides in the treatment of cancer, but at the present time it is limited to particular cases of local involvement, or to inoperable conditions. Radium treatment can hardly be classified in elective cases as being in any way in competition with the surgical treatment of cancer of the rectum except for epithelioma of the anus.

Operability.—Operability is a most important question. If the operability is high in a given clinic the mortality will be high. The reverse is true of a low operability, for if only the best cases are selected

* Presented before the Southern Surgical and Gynecological Association, December 11, 1916.

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for operation, the risk will be less. In order that the student may judge operative results all statistical reports must include a statement regarding the operability. Cripps performed radical operations for cancer of the rectum on only 107 of 425 cases, an operability of less than 25 per cent. In the five years preceding 1916 our total operability was 53 per cent., but in the last three years it rose to 71.8 per cent., indicating that a chance for cure is now being given to a larger percentage of patients with this otherwise hopeless condition than formerly. That the operation is becoming more extensive is shown by the fact that in 6 cases we have performed, in addition, a total hysterectomy; in 12 cases we removed the posterior wall of the vagina; in 6 cases the posterior wall of the bladder; in 11 cases a part or all of the prostate, with one or both seminal vesicles, and in 6 cases one or more coils of small intestine. All of these procedures were necessitated by contact extension of the disease.

Mortality.—Of 753 patients in the Clinic a radical operation was performed on 430, with a general operative mortality of 15.5 per cent. Before 1910 the operative mortality was 17.8 per cent. From 1910 to 1913 it was 17.7 per cent., the operability being 51 per cent. In this earlier period a higher percentage of cases was seen late. Even at the present time 14 per cent. of the patients with cancer of the rectum observed have not had a complete physical examination, although they have been under treatment elsewhere, and some even have been recently operated on for hemorrhoids. In 1913, 1914 and 1915 the mortality was reduced to 12.5 per cent., the operability was raised to 71.8 per cent. and the operative efforts were more radical.

Judging from the character of the colonic contents it would seem that the lymphatic system of the large bowel is very inactive, very much less active than that of the small intestine. For this reason cancer remains a local disease for comparatively long periods of time. That metastasis through the lymphatics is somewhat modified also by age is evident from the fact that in old people cancer remains a local disease longer than in young people. In a considerable number of necropsies performed on persons who have died from cancer of the rectum without operation it is found that there was little or no glandular involvement, death having been caused by perforation, peritonitis or obstruction. The question as to operability and probable operative risk can often be answered by a general examination. In many cases, however, it is necessary to make an abdominal exploration to determine the advisability of a radical operation.

Prognosis.—Of the number of patients operated on, none less than

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three years ago, one-third lived three years or more and 28.3 lived five years or more. By subtracting the natural death-rate for the age period and the number of years, these percentages become respectively 37.5 and 35.8. Greater knowledge of the disease by the public will improve the present statistics for both the mortality and the cure.

The question of control of the bowels must be considered from several standpoints. Colostomies and uncontrolled intestinal openings for the escape of fæces, whether they are abdominal or perineal, are much alike if the sigmoid loop is destroyed in making the new opening. As the left side of the colon is largely muscular and there is no impediment to the discharge of bowel contents after they have passed the splenic flexure, the patient with no anal control and with the sigmoid loop eliminated is much better off with an abdominal than with a perineal anus. If with loss of the anus the sigmoid loop can be retained, the control will be fair, except in case of loose bowel movements. Gas, however, is not controlled. If the cancer is low and the patient is obese, or there are other special reasons, a perineal operation may be chosen without abdominal exploration. With modern technic, however, various forms of abdominal colostomy are possible by which a very fair degree of control can be maintained and abdominal exploration permitted. Undoubtedly a considerable percentage of the Kraske operations done without abdominal exploration were on patients who had no possibility of cure because of internal metastases. Also much of the failure as to permanency of cure by the operations of earlier days was due to lack of exploration and to extraordinary efforts to preserve the normal or posterior location of the anus. Before 1900 the mortality was approximately 20 per cent. with over 90 per cent. of recurrence. We believe that much of the progress in the surgery of cancer of the rectum has come from abdominal exploration and the abdominal colostomy with the sacrifice of a large area *en bloc* of the diseased bowel. The main purpose of the operation being to cure, the best results are secured when unhampered by any special effort to re-establish the normal control of the anal outlet, except when it is indicated by reason of the location of the cancer. While the union of resected intestine within the abdomen is not followed by stricture, that effected outside of the peritoneal-lined abdomen is practically always followed by stricture, and will usually necessitate some form of colostomy after much effort to maintain the lumen. This is the more true if there is good control of the anal sphincter and the less true if the sphincter is paralyzed. As to the extent of bowel to be removed Fagge shows that the disease may extend two inches lower than the apparent growth, while according

to Handley it can be found microscopically more than double that distance above the manifest disease. Such, however, are advanced cases and each individual case must be dealt with on its own merits. In the surgical treatment of malignancy, modern progress has been made by earlier diagnosis and increasingly radical operations. Local recurrence calls for exploration.

The term "rectal cancer" is applied to such growths as are found anywhere between the anus and the lower sigmoid. On anatomic grounds the first inch and a quarter is the anal canal that is lined with pavement epithelium. About 6 per cent. of cancers of the rectum are found in this area. Here appear the epitheliomas and extensions of adenocarcinoma from the lower rectum. Very early local epithelioma may be successfully treated by local excision or destruction by cautery. More extensive disease necessitates the Cripps operation of excision of the anus, which should also include the removal of the inguinal glands, this region having a double lymphatic return. From the anal canal to the peritoneal-covered intestine is the lower rectum, in which are found 24 per cent. of the malignant growths of the region, usually adenocarcinomas, the common form of rectal cancer. The Cripps, Quenu-Tuttle and Hartmann operations, with or without the removal of the coccyx, have been the common operative procedures, the upper rectum at times being drawn through the mucus-denuded anal canal, to be sutured outside for maintenance of the normal position of outlet, or more commonly brought to the surface at the former position of the coccyx. The upper rectum extends to the rectosigmoid juncture opposite the third sacral vertebra. The Kraske procedure involves more extensive removal of the lower sacrum with the coccyx, a higher placement of the terminal bowel and a more extensive removal of the rectum. Operation for cancer of the rectum and rectosigmoid should be made by the two-stage interval operation. If by abdominal procedure the division of bowel below the growth can be made at a point which will leave at least one-half inch or more of peritoneal-covered rectum within the cul-de-sac, and the area of the disease to be removed is not too great to prevent coaptation of the divided ends of the bowel, a tube resection can be done with preservation of the control of the anal outlet as a one-stage procedure. A large rubber tube with a one-half-inch lumen is inserted into the terminal proximal opening of the intestine and attached to it by a purse-string suture. The tube is now passed into the rectum from above and out of the anus. As the bowel ends approximate they are sutured and the tube, being further drawn upon, enfolds the suture line into the rectum. A second row of sutures is then applied, and

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upon further traction a third row of sutures. All intestinal contents are passed through the tube and in no way come in contact with the suture line. The anal sphincter is temporarily relaxed by dividing it anteriorly with the cautery. The tube is sutured with catgut to the anus and its position maintained for one week. Cancer of the rectum and rectosigmoid, which cannot be radically removed with the preservation of the peritoneal-covered distal bowel, is best treated by abdominal exploration, permanent abdominal colostomy and a Kraske removal of all of the rectum at a period one week later—a two-stage operation. Cancer of the lower sigmoid extending nearly to the rectosigmoid is well treated by the Mikulicz method, separation of the mesentery and elevation of the diseased loop through the exploratory incision to a position above the abdomen. The sides of the intestine being first attached to each other within the abdomen to prevent the engagement of small intestine, the doubled intestine is sutured to the parietal peritoneum at the point of emergence and the tumor packed roundabout with vaseline gauze. At the end of a few days the diseased area is excised with the cautery, both ends of bowel being left open, the upper acting as a temporary colostomy. From the second to the fourth day it is sometimes necessary, before amputation of the tumor, to puncture the proximal side of the loop with a cautery, to deliver the gases. In some instances the amputation of the growth may be primary, the ends of the bowel being held by crushing clamps for a few days. From eight to ten days following the primary operation long-bladed crushing forceps are applied by passing one blade into each of the intestinal tubes, the tissues being crushed by tightening the forceps each day. Usually on the fifth day they cut through, making an entero-enterostomy from within the intestine. In from one to several weeks later, according to the case, the external fistula may be closed. This three-stage operation is one of the safest for the amount of diseased tissue removed. It overcomes the dangers of leakage from resection. In selected cases Bloodgood has obtained the same result in a primary operation by resecting the growth, closing both ends and connecting the sides of the sigmoid loop with a lateral suture anastomosis, the closed ends of the bowel being brought into the abdominal incision to be opened if necessary. We have accomplished the same thing by excising the tumor, uniting the proximal end of bowel to the sigmoid end-to-side and bringing the distal end of the sigmoid into the abdominal incision but not through the muscle. The end which is invaginated by a purse-string is not opened unless necessary for gas tension. A rectal tube is inserted for additional safety. The combined perineal and abdominal one-stage operation is a very

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radical procedure and is responsible for a high mortality, 20 to 36 per cent. This has been lowered somewhat by Cripps by making the abdominal pelvic dissection, closing the abdomen and, by posterior operation, immediately elevating the rectum and sigmoid, the bowel not being cut off for two or three days. With exceeding safety we have operated by abdominal incision dividing the sigmoid, making a permanent abdominal anus, and after closing the distal sigmoid of bowel with its invaginated end into the pelvic space, closing the brim of the pelvis with peritoneal-covered tissues and peritoneal folds, such as the back of the bladder or the uterus. The total removal of the rectum and lower sigmoid is done at the end of one week through a perineal Kraske incision. By this method the general cavity of the abdomen is not opened at the second operation.

THE INFLUENCE OF ACIDOSIS ON SURGICAL PROCEDURES*

By W. A. LINCOLN, M.D.
OF CALGARY, ALBERTA

THE treatment of most surgical diseases has now reached a fairly uniform and stable condition so that the advances of the future must come from a broader knowledge of physiology and pathology. We must thoroughly know and understand all the various processes that go to make up the complex phenomenon of human life in health, as well as the changes brought about in these processes by various abnormal or diseased conditions. It is of the utmost importance that we recognize and estimate the various factors of safety that nature has provided. Any surgeon with a fairly extensive experience can soon develop a technic and knowledge of the best procedure for certain diseased conditions which he finds as time goes on he is not able to improve very markedly. But by a broader study of the patient and his vital processes he is able to recognize and avoid many pitfalls, especially those not intimately connected with the condition under treatment. Thus may we achieve that for which we so earnestly strive—the lowest possible mortality. The consideration of the condition known as acidosis thus becomes of interest to every surgeon because, as we shall see, the question of the proper reaction of the media in which the body cells function is a most vital one to all forms of life. Crile,¹ in an extensive study of the subject, has pointed out that an alkaline medium is necessary for all life. When the soil becomes acid it must be fertilized by adding alkali. Thus also in the living organism an alkaline medium is necessary to the continuation of life, and as would be expected, a somewhat complex process has been built up to see that the necessary alkalinity is always maintained. There are two factors to be considered in this process: (1) Production of acids; (2) their destruction or elimination.

Excessive loss of bases, as in cases of severe diarrhoea, may have an influence, but no conclusive work has been done to demonstrate that in these conditions more base than acid is lost.

(1) *Acid Production*.—Crile¹ has shown that almost every activity of life produces acid. Every movement, every emotion, every injury,

* Read before the Alberta Medical Association, September 21, 1916.

every degree of fever, every reaction to infection or auto-intoxication, every heart-beat or respiratory movement, and more especially such an abnormal condition as the administration of an anæsthetic, and such diseased conditions as Graves' disease, post-operative hyperthyroidism, strychnine poisoning, etc., where there is an intense liberation of energy, but most important of all are those conditions where the body is unable to obtain or assimilate sufficient carbohydrates for its needs.

(2) *The elimination of acids* is brought about in both gaseous and solid forms. In the gaseous form as CO_2 from the lungs, the consideration of which we do not need to discuss. The final portals of exit from the body for the acid products which are in solution in the different body fluids are the kidney tubules and the sweat glands. These by-products are at first not suitable for elimination, but must be changed by taking sodium, potassium, and ammonia from the body and changing them into harmless salts such as phosphates, sulphates, chlorides, urea, creatin and creatinin. In these forms they can be eliminated without injury to the kidneys. Crile has shown that the transformation takes place through the agency of the brain, the liver, and the adrenals. This mechanism is ordinarily quite capable of taking care of the acids formed in health with a large margin of safety. There are two ways in which it may, however, break down.

1. By an incomplete acid destruction or elimination.
2. By a too extensive acid production.

1. Under normal conditions the kidney excretes a very considerable amount of acid chiefly in the form of acid phosphates. Howland and Marriott² have shown that in severe cases of diarrhœa there is an increased phosphatic content in the blood and they consider the retention of the acid phosphate the most probable cause of acidosis occurring in cases of severe diarrhœa.

2. While in some cases the excretory mechanism may be at fault, the main cause of the condition and, for all practical purposes, the only one we need consider is an increased production, and this to a somewhat marked extent, because, as we shall soon see, the body is capable of neutralizing acid production far exceeding the normal. It may be well here to state that what really occurs is a decreased alkalinity of the blood and it is never carried to the point of actual acidity, death occurring long before this point could be reached.

Let us now examine those diseased conditions in which an increased production of acid is found. We might enumerate them as: (a) Diabetes; (b) starvation (ulcers, fevers, acute abdominal con-

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ditions, prolonged vomiting, diarrhoea); (c) periodic cyclic vomiting; (d) delayed chloroform poisoning; (e) pernicious vomiting of pregnancy; (f) salicylate poisoning.

If you examine these conditions carefully you find one common underlying condition in all, viz.: the inability to obtain or assimilate carbohydrates. Allow me to briefly review how the lack of carbohydrates produces increased acid by-products. When carbohydrates fail the organism calls upon its reserve store of fats and proteids, but more especially the fats. Now a certain amount of carbohydrate is necessary to the complete oxidation of fats which are ordinarily oxidized to CO_2 and would thus be eliminated from the lungs without difficulty. But in the absence of carbohydrates the process falls short, probably due to the fact that the carbohydrate molecule contains a large amount of oxygen which is used to help oxidize the fat, and thus some of the fatty acids make their appearance in the blood, such as acetone, diacetic acid and oxy-butyric acid. The body at first defends itself by calling up reserves of sodium and potassium and as soon as these fail it further defends itself by the production of large quantities of ammonia. This is obtained from the metabolism of proteid. Ordinarily the effete nitrogen of the proteid molecule is split off in the form of ammonia salts and this is converted into urea and thus excreted. But in the presence of these acids the ammonia is used to neutralize them and thus escapes conversion into urea. Estimation of the ammonia nitrogen and the urea nitrogen in the urine gives an early indication of the acid formation in the blood. Normally the ratio of the former to the latter is about 5 per cent., and if it rises to 10, 15, or 20 per cent., there is a severe acidosis which is masked by the ammonia neutralization and only when this begins to fail will the acids appear in the urine. Delayed chloroform poisoning is probably only a severe and prolonged form of acidosis produced in a patient with a tendency to acidosis by a long operation with chloroform anaesthesia and the consequent withholding of carbohydrates. In the acute cases there may be very few or no post-mortem changes, but in the chronic cases the changes are those found in acute yellow atrophy with fatty degeneration of the liver, kidneys, etc. Multiple small hemorrhages are also often found in the stomach.

Occurrence.—A varying amount of acidosis occurs in many familiar conditions, such as violent exertion, strong emotions, exhaustion from injury, infection, shock, starvation, hemorrhage, etc. The prominent clinical phenomena in a case of exophthalmic goitre and in post-operative hyperthyroidism are chiefly due to acute acidosis. Women are more

susceptible than men, perhaps due to their greater emotional tendencies. Children are much more susceptible than adults and here it is entirely due to their inability to bear carbohydrate starvation for any length of time. Deprive a child of carbohydrates for thirty-six to forty-eight hours and in most instances diacetic acid will appear in the urine, while the same deprivation in an adult would require a much longer time to produce any effect. The craving of a child for sweets probably has a physiological significance and must be kept in mind when a child is subjected to any prolonged strain, anæsthetic or operation. Brandner and Reimann,³ studying 214 consecutive patients in John B. Deaver's service, found acetone present in 85 per cent. and diacetic acid in 17 per cent. of the cases. The more emotional, frightened or anxious they were invariably the more shocked and the greater amount of acetone was found. Starvation treatment was found to nearly always increase the acetone output. The severity of the pathological condition and the gravity of the operation did not seem to have any bearing on the condition.

Symptoms.—These vary depending upon the severity of the condition, all the way from a slight prolonged post-anæsthetic vomiting to the ones terminating in coma and death. In the mild cases all that is noted is that the patient goes under the anæsthetic with surprising ease and that the breathing is shallow and requires careful watching. There may also be a tinge of cyanosis when the patient is getting plenty of air. Later the patient is restless, vomits easily and the effects of the anæsthetic take a long time to wear off. In the more severe cases the patient may never regain consciousness, or if so, he becomes restless and tosses about. Vomiting is frequent and may be coffee ground in character. Thirst is marked and more or less cyanosis present. The pulse-rate rises and the respirations become hurried. The temperature often rises and may lead to a mistaken diagnosis of sepsis. The patient soon becomes comatose and in an adult may be delirious, death supervening in from twenty-four to thirty-six hours.

Treatment.—This becomes much simplified if we keep in mind that for all practical purposes acidosis means carbohydrate starvation. The acidosis produced by exertion, emotion, infection, anæsthesia, etc., in an adult can usually be handled by the organism without difficulty, provided there be not superadded that produced by a too severe withholding of carbohydrates. Thus the treatment in most cases reduces itself to the prevention of further trouble by supplying sufficient carbohydrate and to the neutralization of those acid by-products present by the administration of alkali. Certain classes of cases must

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be recognized as predisposed to the development of acidosis and thus receive special attention. These are children, patients suffering from forms of exhaustion, such as from starvation due to various pathological conditions, hemorrhage, chronic infections, extreme nervousness, hyperthyroidism, diabetes, etc. The urine must be carefully examined for diacetic acid, or better still, the ammonia and urea nitrogen estimated. These cases must not receive severe purgation and carbohydrates must be allowed right up to the time of operation, best in the form of glucose, either by mouth or rectum. Sodium bicarbonate may be administered until the urine is faintly alkaline. Wakefulness and nervousness should be controlled if possible and all forms of exertion prohibited. The operation should be performed as rapidly as consistent with proper technic and under local anæsthesia if any degree of acidosis be present. Crile⁴ has shown that the anæsthetic distinctly increases the acidosis. He advises against the use of morphia after the anæsthetic as it prolongs the period of neutralization, but when given before the anæsthetic it lessens the amount necessary for anæsthesia and thus has a tendency to lessen the acidosis. Shock should be guarded against by the subcutaneous or intravenous injection of saline solution. There are two lines of treatment for acidosis following operations. The administration of alkali in the form of sodium bicarbonate which controls the symptoms by neutralizing the acids, and the administration of carbohydrates best in the form of glucose which overcomes the production of the excessive acid by-products, when they are due, as in most instances they are, to carbohydrate starvation. These may be administered by the mouth, by the rectum or intravenously. In the mild cases, the best method is to put them in the saline solution and use by the Murphy drip method. Glucose can be so used in percentages of 5 to 10, but is somewhat irritating and cannot be used for any length of time. Sodium bicarbonate may be given in the proportion of one to two drachms to the quart and may also be administered by the mouth until the urine is faintly alkaline. In the severe cases of coma present or threatened, a quart of 5 per cent. glucose and two or three drachms of sodium bicarbonate should be administered intravenously. The solution must be pure, fresh and well sterilized. We have in glucose a food substance which can be introduced directly into the circulation and readily utilized by the organism. Experiments by Vezar and Von Fejar⁵ have shown that there is a definite increased oxidation after its introduction. A good practical method in children is to let them have loaf sugar or pure candy up to a short time before operation and as soon after as they will take it.

I can best illustrate the importance of this subject by recounting the histories of two cases. The first I saw in consultation during the early days of my practice before the question of acidosis had been brought to the notice of surgeons. The patient was a well-nourished boy of five years, suffering from a simple inguinal hernia. The parents were intelligent and well-to-do and, desirous of taking every precaution, thoroughly starved the child for several days before operation. The operation was easily performed under ether anæsthesia and the patient came through it nicely. Following the operation he had a tendency to vomit and again through excessive zeal food was rigidly withheld. With our present knowledge it is easy to foresee the result. On the second day the patient was still vomiting a little, was restless and the pulse and respirations more rapid than normal. The temperature rose to 103° ; the pulse became very rapid and weak. The patient became cyanosed and gradually comatose. The urine was not examined for diacetic acid but a slight trace of albumen was found, as is the case in most post-operative cases, and the condition was thought to be due to uræmia and treatment for this was instituted, which of course only hastened the ultimate end. Thus we have enacted one of the tragedies of surgery: A strong, healthy child—a simple operation—a fatal result. Had the condition been recognized it would have been a simple matter to overcome it, as the next case will demonstrate.

I saw this case only a few months ago. It was a little girl of nine years, brought in from the country suffering from acute appendicitis. The diagnosis had been made three days before by the family physician. The parents had some knowledge of the condition and had rigidly starved the patient for the three days. The appendix was found acutely inflamed and removed under ether anæsthesia without difficulty, in about twenty minutes. Following the operation the nurses were instructed to begin nourishment early, but the patient was indifferent and was not urged. On the second day the mother was sitting by the bedside and noticed a strange expression on the child and on speaking to her obtained no reply. She then found that she could not rouse her. When I saw her she was deeply unconscious; the pulse was 140 and thready; respirations rapid and jerky, with a tendency to Cheyne-Stokes. Face and hands were cyanosed and the face and eyes turned strongly to the left with some twitching of the eyes and limbs, especially on the left side. The teeth were tightly clenched and she was unable to swallow. I suspected acidosis, but no urine could be obtained. However, feeling fairly sure of my diagnosis, I gave her intravenously two pints of saline solution containing 5 per cent. glucose and two drachms of

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sodium bicarbonate. A change in the pulse and color could be noted at once and inside of two hours she was perfectly conscious, asking what had happened. Thus was a tragedy avoided. Carbohydrates were pushed and she made a perfect recovery. The urine first obtained after this contained diacetic acid, which soon disappeared.

The conclusions I wish to emphasize are the possibility of acidosis occurring in many conditions besides diabetes, and the necessity for surgeons to have their eyes open to its dangers. The necessity of a proper and continued examination of the urine for acid by-products and the danger in the preparation of patients for operations of a too prolonged starvation, especially in the case of children or those suffering from any form of exhaustion.

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THE CHEMOTHERAPY OF EXPERIMENTAL BACTERIAL INFECTIONS *

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FOR ages one of the chief aims of those concerned in the treatment of the sick has been the discovery of specifics. Consciously and unconsciously physicians have ever experimented with this purpose in mind and largely by empirical ways and means; despite the enormous amount of work entailed and the very large numbers of both organic and inorganic substances employed, only two or possibly three specifics have been discovered up to very recent years, namely, mercury for the spirochæte of syphilis, quinine for the plasmodium of malaria and salicylates for the infectious agent of acute rheumatic fever. In comparison with this rather poor record of definite achievement covering hundreds of years of effort is the brilliant discovery by Ehrlich of the specific spirochæticide arsenobenzol, after comparatively few years of work, and a striking demonstration of the value of the "prepared" mind and organized and systematic reasoning and experiment.

In a strict sense the term chemotherapy may be made to include the therapy of disease with any organic or inorganic chemical; indeed Wright has recently advocated the use of the term to include those immunity principles in the blood and other body fluids known as antibodies and regarded as being chemical substances. The meaning given the term by Ehrlich, however, would appear restricted to those chemicals built up synthetically and systematically with the object of rendering them more and more parasiticide for a certain microparasite or group of microparasites and less and less organotropic or toxic for the body cells. Future researches in the field of chemotherapy along systematic and scientific lines may discover chemicals already well known and requiring no further modification, but it is more likely that efforts in this field must be spent on the tearing down or building up of chemicals regarded on the basis of experiment or clinical experience as being

* Read before the Philadelphia Academy of Surgery, November 6, 1916.

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hopeful "leads" or "bases" until the desired properties of extreme parasitotropism and low organotropism are acquired.

With discoveries in the field of bacteriology in the early eighties and of chemical substances readily demonstrated as possessing bactericidal properties in high degree in test-tube experiments, high hopes were entertained and expressed that the treatment of bacterial infections would soon be solved and greatly simplified. It was not long, however, before laboratory and clinical experiments demonstrated that chemicals possessing a high degree of bactericidal power outside of the body may be so highly toxic and their bactericidal properties so altered in the living body, as to prove well nigh worthless in the treatment of bacterial infections. The mercurials are notable examples of this class of compounds; at present in the Dermatological Research Laboratories of the Philadelphia Polyclinic we are endeavoring to prepare new synthetic mercurials with decreased toxicity and enhanced parasitocidal properties, believing that this group of substances possess great possibilities as efficient bactericidal and protozoöcidal substances in the living animal.

At present more advance in chemotherapy has been made in the field of protozoön than in bacterial infections. Such protozoa as the trypanosomes and certain races of spirochætes are readily adapted for extensive experiments in laboratory animals, proving comparatively simple in their handling and yielding results in chemotherapeutic experiments which are definite and decisive in a short space of time; for these reasons they have been adopted in most laboratories for researches in chemotherapy. Furthermore, it would appear that the problem of chemotherapy of protozoön infections is simpler than that of bacterial infections in that the protozoa, as trypanosomes and spirochætes, are more susceptible or open to the influence of chemicals in the body fluids, and that other modifying factors, as localization of the infection, accessibility to the influence of a drug and tissue changes, are less than occur in bacterial infections. The intensive work in syphilis during the last twelve years, including the discovery, isolation and artificial cultivation of *Treponema pallidum* and the Wassermann reaction, has served to focus the attention of scientific medicine upon this disease and protozoön infections in general.

The aim of chemotherapeutic studies is the search for specifics. A group or polytropic specific, as that of salvarsan for different spirochætes and even trypanosomes as well, is to be hailed as a distinct advance; the ultimate aim of chemotherapy, however, is the discovery of a monotropic chemical or one highly specific for a certain micro-

parasite. For example, it is highly probable that further modification of salvarsan, tending to increase its spirochæticidal properties in general and for *Treponema pallidum* in particular, will greatly increase its value in the treatment of syphilis.

From the standpoint of experimental chemotherapy, drugs may be said to possess two properties of paramount importance, namely, an organotropic, or influence for the body cells which usually expresses itself in certain dosage by toxic effects, and, possibly a parasitotropic or destructive effect upon some animal or vegetable microparasite in the living animal. The aim of the experimental chemotherapeutist is to lower the former and enhance the latter, so that the chemical under study may safely be given in such dosage as will be effectively parasitotropic in high dilution in the body fluids. Under these conditions the chemical may prove beneficial in the treatment of a disease, not only by reason of its parasitotropic or direct destructive effect upon a particular microparasite, but also by reason of stimulating the production of antibodies by the body cells or by inducing a leucocytosis; by facilitating phagocytosis and by pharmacological activities on the respiratory, cardiac, heat and other vital centres. For example, salvarsan may prove of value as a hæmatinic, not only in the anæmia of syphilis, but likewise in anæmias of non-syphilitic origin; according to our experiments ethylhydrocuprein and cinchona compounds in general appear to influence the pneumococcus not only by reason of their pneumococidal power but by inducing leucocytosis and stimulating phagocytosis as well possibly by a pharmacological influence upon the higher nerve centres.

In the rational development of the chemotherapy of bacterial and protozoön infections it is desirable, if possible, to commence experimental work with a substance or substances possessing some definite destructive effect upon the microparasite under study. This parasitotropic effect may be apparent only in test-tube experiments, in which event an effort is made to lower the toxicity or organotropism of the substance with, or even without, an increase of its parasitotropic power, in order that it may be administered in such quantity as will exert in the living animal an inhibitory or killing action on the microparasite under study without injury to the host.

In chemotherapeutic studies it is highly desirable to work with a base which offers most hope for successful development, and, in the present state of our knowledge, chance or accidental discovery must play an important rôle in the discovery of the "lead." Substances are selected or prepared upon as systematic a basis as possible and tried

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out by actual experiment; those yielding encouraging results are then subjected to various systematic modifications with experimental trial of the new compounds. In this manner chemotherapeutic research proves to be costly and laborious, as amply demonstrated by the prolonged and costly series of experiments directed by Ehrlich, resulting in the discovery of salvarsan and related compounds.

In the discovery of "leads" and the study of new compounds, animal experiments are of primary importance, not only because these are the sole means of determining the organotropic or toxic effects of the compounds, but because they are the sole means of determining the actual parasitotropic or therapeutic effects. In chemotherapeutic studies in any particular disease it is highly desirable that the causative micro-parasite be capable of artificial cultivation or at least prove transmissible to a lower animal; furthermore, it is desirable that the micro-parasite yield a uniform infection of the experimental animals of not too severe a character; produce definite lesions easy of detection and study and as far as possible similar to those found in man, or cause the death of the animal in a given period of time. For studies in bacterial chemotherapy virulent cultures of the pneumococcus are admirably adapted for work among mice and rabbits, although other micro-organisms as the staphylococci, streptococci, tubercle bacilli and others may be employed. As previously stated, chemotherapeutic studies in bacterial infections may be conducted on a definite or narrow scale with the microorganism of one disease, as in tuberculosis, or upon a wider scale as the search for a synthetic chemical possessing more general bactericidal properties. For example, chemotherapeutic studies in syphilis have shown that a trypanosome may be used as the test microorganism; in bacterial chemotherapy we are using virulent strains of pneumococci and staphylococci in most of our work, although it remains to be determined whether a compound showing a high bactericidal power *in vitro*, or even *in vivo*, on one microorganism, as *B. typhosus* or the pneumococcus, will show a similar effect upon the microorganisms of other diseases, as in tuberculosis or anterior poliomyelitis.

In chemotherapeutic studies in bacterial infections, test-tube experiments may be said to possess a definite value in preliminary orientation in the development of "leads," in the study of new compounds as they are produced and in the development of monotropic drugs. Experimental data at hand tend to show that substances possessing a high bactericidal activity *in vitro*, and particularly in a menstruum of fresh sterile serum, are more likely to exert an inhibitory or bactericidal

action *in vivo* than substances which are less active. For example, Morgenroth's ethylhydrocuprein exerts a very high bactericidal action on the pneumococcus *in vitro* and is likewise effective to some extent *in vivo*; other cinchona derivatives, including certain salts of quinine possessing more or less bactericidal value *in vitro*, are likewise effective to a certain degree *in vivo*. We have also found that arsenobenzol possesses a high degree of parasitotropic activity on *T. equiperdum in vitro*, and, as well known, this drug exerts the best parasitotropic effects *in vivo*. Unfortunately, however, as previously stated, other substances that are highly bactericidal *in vitro*, as the mercurials, also possess a high degree of toxicity for the living animal, and all efforts of the chemotherapeutist have so far failed to lower materially the toxicity of these compounds. I have given elsewhere a more complete discussion of the relation of *in vitro* tests to the problems of the chemotherapy of bacterial infections with a comparative study of various methods based upon work with the pneumococcus.¹

As previously stated, the problem of the chemotherapy of bacterial infections is proving more difficult than that of protozoön infections. At the present time it may be stated that a start has been made, but so far researches have not yielded a drug of proven clinical value. Morgenroth's discovery of the pneumococidal value of optochin (ethylhydrocuprein) constitutes a distinct advance, but is not of proven practical value. In our opinion this drug bears a relation to bacterial chemotherapy somewhat analogous to that presented by atoxyl toward the chemotherapy of protozoön infections a few years ago, and at the time when Ehrlich decided to employ it as a base and lead for his work with the arsenicals. More recently Koga has reported interesting and encouraging results in the chemotherapy of tuberculosis with a copper compound. Without much doubt further discoveries will be made, and a definite and specific chemotherapy of bacterial infections, as those produced by the pneumococcus, streptococcus, staphylococcus, gonococcus, *Bacillus typhosus*, *Bacillus tuberculosis*, *Bacillus lepræ* and others, is within the realm of possibility; it is quite certain, however, that these discoveries are not likely to be made by happy-go-lucky hit-or-miss experiments, but by the prepared mind and by careful, painstaking, prolonged and costly experiments and with the realization that much work must be done before definite results are obtained, and, that indeed individual efforts may not bear immediate fruit at all.

¹ Kolmer, J. A., Cohen, S. S., and Heist, G. D.: Various Methods for Determining the Bactericidal Action of Substances *in Vitro* and Their Relation to the Chemotherapy of Bacterial Infections. *Jour. Infect. Dis.* (in press).

ACUTE OSTEOMYELITIS OF THE SPINE*

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THE relatively few reported cases have led us to add the following observation of this interesting localization of acute osteomyelitis.

History of Case.—M. R. H., 90773, aged twenty-three, merchant, was admitted to the hospital on August 24, 1916, on account of acute urinary retention. No local cause being found for this condition, he was transferred to the medical service where he was examined by Dr. Schram. The patient looked very septic, the temperature was 104.2° F. (rectal) and pulse 120. He complained of pain over the lumbar region of the spine of a diffuse character. He said he had always enjoyed excellent health except for an infection of the right index finger, requiring operation one month before. Present illness began suddenly with pain in the back, radiating to the left side, and accompanied by high fever and severe night sweats for twelve days before admission.

Soon after the first examination noted above, he had a chill and sweat, the temperature rising to 105.4° F. (rectal) and continued so for the next twelve hours (Fig. 1). The first impression he made of some form of generalized sepsis was strengthened by the observation of the patient during the 24 hours following his admission. The examination of the spine at first had shown only diffuse tenderness over the lumbar and sacral regions, but during the last half of the first twenty-four hours there was retraction of the neck with marked rigidity of the entire spine and symptoms of meningeal irritation (Kernig sign present and suggestion of a Babinski sign and generally increased reflexes). No eye changes were found. Leucocytosis was 14,000. Lumbar puncture was done and pure pus escaped from the spinal canal. Up to this time the diagnosis had been a diffuse meningitis, but, when the staphylococcus aureus was found in pure culture in the fluid obtained by lumbar puncture, the question arose as to the source of the pus as the symptoms were entirely those of spinal irritation.

Radiographic examination showed an area of osteoporosis in the body of the third lumbar vertebra. His symptoms of meningeal irritation increased rapidly during the next twelve hours and

* Read before the Chicago Medical Society, November 15, 1916.

he was transferred to the surgical service of Dr. D. N. Eisendrath, who confirmed the findings of Dr. Schram and suggested further the possible presence of an acute osteomyelitis of the spine in the lumbar region, secondary to the infection of his index finger.

Operation (August 26, 1916).—Laminectomy for drainage of epidural abscess (lumbar region) due to osteomyelitis of third lumbar vertebra. Examination of patient under anæsthesia failed to show any rigidity or other evidence of perinephric abscess, but there was a sense of fluctuation on the left side of the spine in the lumbar region. An incision a little to the left side of the median line showed pus escaping from beneath the deep spinal

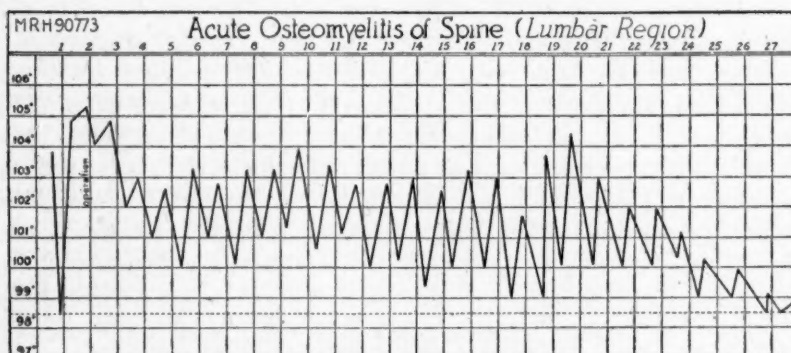


FIG. 1.

muscle (erector spinæ) apparently from the left side of the spinous process of the third lumbar vertebra. Upon reflecting the muscles from the laminae of this vertebra—thick yellow pus was seen to escape from a space in the median line between the spines of the third and fourth lumbar vertebrae, *i.e.*, from within the spinal canal. The laminae and spines of the third and fourth vertebrae (lumbar) were removed and the cauda equina was exposed. It was covered with reddish fibrinous material and completely enveloped in thick pus lying in the epidural space. There was an apparent walling off of the suppuration in an upward direction, but towards the sacrum there was free pus around the cauda. The vertebral bodies could not be seen, but the X-ray had shown a roughened condition of the third lumbar body and this was no doubt the source of the pus. Two gauze and rubber tissue drains were inserted at each end of the wound into the spinal canal and a rubber tube at the centre, the wound being closed in layers. Cover slips of the stained pus showed a staphylococcus. The course of the temperature is shown in Fig. 1.

On the morning following the operation the rigidity of the

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neck and spine were absent. The reflexes were less active, the Kernig and other irritation symptoms much diminished. This decrease in the reflexes continued until they became normal, as at present time. For a time patient complained of pain and paræsthesiæ in lower extremities, but there were no objective findings.

Remarks.—The relatively small number of reported cases of osteomyelitis of the spine is probably because diagnosis is not made.

In many of the cases, the symptoms of the systemic infection completely overshadow those of the local disease. The most thorough review of the subject is that of Donati¹ in which he reports one case of his own and collected 55 cases published up to 1906. Kirmisson² found in 1909 the report of nearly a hundred cases, but he has no doubt included osteomyelitis of the sacrum, which Donati and the later publications have excluded, first because there is little likelihood of escape into the spinal canal and second because the disease is most frequently found in the lateral portions of the sacrum which embryologically correspond to the ribs. The majority of writers prefer to take up osteomyelitis of the sacrum in connection with the pelvis. Volkmann³ up to 1914 collected 84 cases (including one from Payr's clinic). He believes cases of sacral osteomyelitis should be excluded.

It may be of interest to review some of the more important observations in regard to the disease. The largest number of cases occur between the tenth and twentieth year. Although trauma plays a rôle as an exciting cause, the most frequent etiological factor is the presence of a suppurative focus elsewhere, *e.g.*, furuncle, osteomyelitis focus, paronychia, etc. In fourteen of twenty-one cases collected by Donati and in twenty-four of thirty-five cases reported by Volkmann, the staphylococcus was found in pure culture.

The lumbar region is the one most frequently involved, according to Donati (twenty in fifty-six), while in the statistics of Volkmann the largest number are found in the dorsal region. As a rule several vertebræ are involved. The entire vertebral body and arch was the seat of the disease in a smaller number of cases than was the case of the body or arch alone. Involvement of the body is more often followed by invasion of the spinal canal and the development of peripleuritic and psoas abscesses than that of the arch.

The majority of cases (sixty-eight per cent.) run an acute course and the mortality is correspondingly higher in this class than in the

¹ Archiv für klinische Chirurgie, 1906, vol. lxxix, p. 1110.

² Presse médicale, 1909, No. 38.

³ Deutsche Zeitschrift für Chirurgie, 1914, vol. cxxxii, p. 445.

subacute cases. Donati found that in six of twelve deaths in the acute form, death was due to the invasion of the spinal canal. The delirium and other symptoms of generalized sepsis are often so marked that death occurs before a diagnosis is made.

In the less severe form, the symptoms vary greatly. Severe pain over the affected vertebra associated with rigidity of the spine is of the greatest value in making a diagnosis. The same is true of localized oedema and tenderness. Of aid in recognizing the presence of an acute pyogenic focus in the cervical vertebra are rigidity of the neck, neuralgias in the occipital region and early signs of compression. In the dorsal spine the pus is very apt to gravitate in a forward direction, resulting in the formation of a peripleuritic abscess. In a similar way a suppurative inflammation of the psoas muscle may be the result of osteomyelitis of the lumbar region. Severe pain due to pressure on the nerve roots rarely occurs except in the cervical region. The most frequent symptoms then are pain in the back, rigidity, oedema and swelling. The X-ray is a great aid if the symptoms as in our case do not enable one to localize the disease. The same is true of lumbar puncture if one obtains pure pus as in the case reported by us. In those cases in which the general symptoms predominate, one must exclude typhoid, acute rheumatic spondylitis and meningitis.

The escape of the pus into the spinal canal may result in (a) an extradural abscess with symptoms of meningeal irritation as in our case, (b) in pressure upon the cord with symptoms of compression corresponding to the level involved, (c) a purulent meningitis. The mortality of osteomyelitis of the vertebra is highest when the cervical region is involved and least in the dorsal region and at a point between these two extremes in the lumbar region. Operative interference is indicated as soon as a diagnosis is made. Unfortunately the condition has been recognized in only one-third of the published cases according to Volkmann. Simple incision and drainage may suffice, but it is best to do a laminectomy as in our case so as to provide for free drainage. If the focus in the bone can be found its removal is permissible if the risk of the operation is not greatly increased; otherwise it is best to be conservative and to wait for sequestration. Healing usually occurs without the formation of a kyphosis. If a peripleuritic or psoas abscess be recognized early incision and drainage are indicated. A stereoscopic röntgenogram of the chest combined with fluoroscopy should be made whenever the dorsal region is involved. No doubt the number of reported cases will increase rapidly as the disease begins to be recognized.

THE SIGNIFICANCE OF GIANT-CELLS IN BONE LESIONS

BY GEORGE BARRIE, M.D.

OF NEW YORK CITY

THE significance of the presence of giant-cells in bone lesions, particularly the type cell classified under the terms "foreign body, scavenger (Barrie), multinucleated, myeloplax, or osteoclast," is still an open and debatable question among many workers interested in bone surgery and pathology.

While differing opinions are expressed, it may be stated: probably a majority accept the view that when numerous cells of the above-mentioned type are found in bone lesions, they signify a benign condition, provided the other cells composing the histopathologic picture give no evidence of malignant change.

The varying perceptions that prevail among those interested in the subject may be summed up as follows: One group maintain that the presence of such giant-cells in lesions is an evidence of reactionary inflammatory change only; their presence should be disregarded in so far as tumor formation is concerned. These investigators believe all evidence points to the conclusion that they have no part in actual neoplastic growth. Another group oppose this view and contention, and insist that the giant-cells commonly found in certain bone lesions and tumors are an integral part of the mass. They state that the cells form a portion of, and may determine the character of, a neoplasm. This group refuses to accept other than neoplastic significance for the giant-cells when their presence is noted in certain pathologic processes in bone.

And, finally, there remain a number of observers unable to decide at the present time which may be the correct interpretation.

Pathologists also express opposing views in their writings and teaching regarding the origin of the giant-cells. Divergent opinions in this respect are very pronounced.

Another active subject of contention and debate is the function the cells possess. This lack of agreement among pathologists, and their apparent inability to definitely decide the rôle all giant-cells play in pathologic processes and the exact position that should be assigned them has led to considerable confusion. The clinical surgeon especially has felt the need of a more clearly defined opinion upon which

might be based future operative procedures. At the present time, many surgeons more or less discard and disregard the microscopic diagnosis of a giant-cell content. They rely upon their own interpretation of the clinical, X-ray, operative, and gross pathologic appearances of the lesion, as a whole, for guidance and decision in their efforts at operative therapeutic cure.

This attitude is perhaps unfortunate. In a great many instances a fairly conclusive and correct diagnosis may thus be made, but in order to obtain complete and positive data, a microscopic finding, confirmatory or otherwise, is always desirable and sometimes essential.

Bearing these facts in mind, a consideration and discussion of the origin, function, and significance of giant-cells seems justified at this time, and particularly the relation and position they occupy in the lesion described by different writers under the following terms: (1) Myeloid sarcoma; (2) medullary giant-cell sarcoma; (3) myeloma; (4) medullary giant-cell tumor (Bloodgood); (5) chronic hemorrhagic osteomyelitis (Barrie).

Origin of the Giant-Cells.—Workers noted in the realms of pathology still hold dissenting views regarding the origin of multinucleated giant-cells. It has been recognized for many years that sterile foreign particles kept in soft tissues attract numerous endothelial leucocytes to them. Microscopic studies have shown that the leucocytes may fuse in their efforts to surround and dispose of such substances. In this way multinucleated giant-cells are formed. The observation of Zeigler and others, of the behavior of the endothelial leucocytes in this manner, and their fusion into giant-cells, gave rise to the term "foreign body giant-cell."

It is not yet a generally accepted fact that this is the only source of origin of such type cells. Adami, quoting Von Hauseman and accepting his classification, attempts to distinguish between what is termed the myeloplax, or osteoclast, and the so-called multinucleated foreign body, or scavenger giant-cell. He insists that the so-called myeloplax, or osteoclast, is of myeloblastic origin, but agrees that what are usually termed foreign body giant-cells arise from endothelial leucocytes. Mallory, as a result of his independent studies, experiments, and investigations, advanced the opinion in 1910 that the so-called myeloplax, or osteoclast, of Kölliker, and the multinucleated foreign body giant-cell is one and the same histologic entity—that is, the cells in all respects respond to the same criteria, and conform identically to all staining methods. In his later research and studies, he has demonstrated that cells of true myeloblastic origin give bio-

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chemical reactions apparently not obtainable from the so-called myeloplax, or osteoclast. He concludes that the latter-named cells are, in fact, formed from the fusion of endothelial leucocytes.

Many modern writers now agree that the commonly known foreign body giant-cell has its origin in this way. Perhaps a majority do not concur in the opinion that the so-called myeloplax or osteoclast originates from the same source. Some writers assert they arise from osteoblasts, and others that they are the product of the bone-marrow. Another theory regarding giant-cell origin is that they are formed through rapid nuclear multiplication within the cell body.

The main characteristics of the giant-cell termed myeloplax, or osteoclast, multinucleated, scavenger, and foreign body may be roughly classified as follows: (1) Nuclei may range between 2 and 200. (2) Rather uniform size and shape of nuclei. (3) Absence of mitosis or mitotic figures. (4) Arrangement of nuclei may be either central, peripheral, unipolar, or scattered over the cytoplasmic mass. (5) Vacuolation and degenerated areas in cytoplasm are more frequently seen in large cells containing many nuclei.

One may occasionally observe apparent coalescing of two giant-cells to form a very large cell.

After careful study of numerous sections taken from bone-lesions and induced pathologic processes in soft tissues, it has seemed to the writer impossible to differentiate as to which cells might be termed myeloplax, and which foreign body giant-cell.

True Tumor Giant-Cells.—There is apparent unanimity of opinion regarding the origin, function, and significance of the true tumor giant-cell termed by von Hauseman, and adopted by Adami and others, "parenchymatous giant-cell." This type is observed on the rarest occasions in bone lesions. When its presence is noted in any pathologic process, a high grade malignancy is assured. It is well described by Stewart as follows: "Here the nuclei are extremely irregular in size and shape, often presenting lobes and indentations, while most of them are large size; not infrequently nuclei of enormous size are met with, and in such cases the giant-cell may be mononuclear. The number of nuclei seldom exceed six, and most of the cells form one to four only. They usually lie clumped together in the cell so that it is often difficult to determine precisely how many are present.

"Mitosis within the giant-cell is of common occurrence and very frequently this is of the multipolar type. Vacuolation is rarely seen."

Stewart's description is very clear. It differs in large degree from the appearance of the giant-cell common to bone lesions.

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The pathologic process in bone possessing more than passing interest to the surgeon is the lesion described under these terms: Medullary giant-cell sarcoma; myeloid sarcoma; myeloma; medullary giant-cell tumor (Bloodgood); chronic hemorrhagic osteomyelitis (Barrie).

The giant-cell content in this lesion has heretofore been the large factor in reaching histologic diagnostic conclusions. The gross appearance these tumor-like masses present is now generally conceded to resemble hemorrhagic granulation tissue.

The opposing views held regarding the significance of giant-cells found in this bone lesion are, perhaps, best stated by Adami on the one hand and Mallory on the other. Adami records the following opinion: "For myself, I cannot but hold that they are specific constituents of the tumors, every whit as much as the osteoclasts of Howship's lacunæ are specific constituents of normal bone-marrow. I would lay down, indeed, that the bone-forming and bone-destroying cells are the primary constituents of the bone-marrow, giving rise to myelomas of the first order, and that the hemal mother cells are secondary, giving rise to myelomas of the second order which indeed may originate elsewhere wherever these hemal mother cells have a normal existence."

Mallory sums up the diametrically opposed view as follows: "They are foreign body giant-cells similar to the osteoclasts of normal bone, and are due to the fusion of endothelial leucocytes attracted into the tumor by the presence chiefly of lime salts, which they dissolve and remove. They signify, usually, disintegration of bone. The tumor containing foreign body giant-cells should be classified according to the nature of the other cells present in the tumor; the foreign body giant-cells should be disregarded. They do not signify either rapid growth or malignancy."

Ziegler and others have maintained that the presence of this type giant-cell does not form an essential characteristic of a peculiar type of tumor. They are accidental, resulting from continued irritation.

The writer has been able to make experimental studies which seem to demonstrate that the significance of the giant-cells is fully accounted for when their scavenger function is recognized. Their formation, existence, and function are apparently dependent upon the presence in the tissues of alien products that are inactive, apparently non-infective and non-purulent.

Observation and study of many bone lesions of the type described by the writer as chronic hemorrhagic osteomyelitis, in which areas are often found containing a large giant-cell content, leave no doubt (in the writer's opinion) of the correctness of Mallory's views and teaching.

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Experimental reproduction of so-called medullary giant-cell sarcoma, which may be brought about at will by mechanical insult to tissues, further confirms the contention that such giant-cells are not tumor-forming cells, and such lesions are not autonomous growths.

Giant-cells of the scavenger type are sometimes observed in true neoplasms in bone. They should be regarded as incidental. Their presence in bone tumors usually signifies a low grade malignancy.

The tumor-like formation of proliferative granulation tissue masses that form the gross lesions termed "medullary giant-cell sarcoma, myeloid sarcoma, myeloma, medullary giant-cell tumor, and chronic hemorrhagic osteomyelitis," is due to its environment in cancellous bone. The true nature of this tissue cannot be gainsaid, either in its gross appearance or histologically. The masses filling destroyed bone areas are the real evidence of nature's effort at regeneration and restoration. They should not be regarded as neoplasms. They are masses of hemorrhagic granulation tissue formed in response to inflammatory stimuli. Initial cancellous bone destruction paving the way for these lesions may be due to trauma, to change following mild non-suppurating infections, or to some metabolic inflammatory disturbance.

Efforts of the host to restore the complex bony defect begin first in the formation of embryonal vascular granulation tissue highly proliferative in character. Overproduction of this structure for a given need is a common observation. When this occurs, pressure is exerted on the surrounding delicate trabeculae, causing nutritional inhibition, rarefaction, and destruction from pressure necrosis. In this way a vicious circle is established.

Slow progressive increase in size of the lesion may be expected in this stage. It is also during this period that giant-cell formation and activity is greatest.

Increased stimulation, brought about by certain chemotactic properties in the blood, produces a fibrous metaplasia of the granulation tissue. The terminal, or curative stage, may then be said to have commenced. The fibrosis means contraction and retraction of structure and thus removal of pressure upon bony septa, and the prevention of further bone tissue destruction, and, finally, conversion of the hemorrhagic granulation tissue into structure fibrocystic in character.

The first stage of the lesion should be recognized as a chronic (proliferative) hemorrhagic osteomyelitis. The final stage may very appropriately be termed a fibrocystic osteomyelitis.

Quite illuminating is the result of an experiment shown in Figs. 6 and 7. The study for the picture was produced as follows: Under

surgical aseptic technic, a piece of sterile gauze was inserted through an incision in soft parts, the wound then closed and sealed. Some weeks later reopening over old scar and removal of gauze and its contained material was accomplished. The gauze was found surrounded with, and embedded in, hemorrhagic granulations. The illustrations show a high- and low-power cellular picture, quite interesting in that the giant-cells resemble so-called myeloplaxes, scavenger, or foreign body cells enmeshed in gauze fibres.

A similar cellular picture, excluding the gauze fibres, may be observed in bone lesions described as myeloid sarcoma, medullary giant-cell sarcoma, myeloma, medullary giant-cell tumor, and chronic hemorrhagic osteomyelitis.

Other experiments have demonstrated that giant-cells may be formed in any of the tissues in the body where a hæmal capillary circulation is active, similar in their histologic aspects to those credited with producing medullary giant-cell sarcoma, provided a suitable irritative agent is present.

It is difficult in the light of our present knowledge to understand why the presence of these cells in bone lesions should be considered evidence of malignancy, or that they should be credited with producing autonomous growth. There is no doubt they do indicate a mild inflammatory reaction. These characteristics of the cell have been known for a long time, and have been observed in tissues containing sutures, ligatures, and other sterile foreign substances. Their function may be regarded as truly beneficent and free from exerting any malign influence.

The relation of giant-cell distribution to type structure has been rather constant in bone lesions, termed by the writer "chronic hemorrhagic osteomyelitis." They range about as follows: (1) In areas exhibiting marked cellular necrosis—no giant-cells. (2) Areas exhibiting marked fibrosis—very few or no giant-cells. (3) Areas of regenerating vascular granulation tissue adjoining the bone borders surrounding the lesion—few to moderate number of giant-cells. (4) Areas composed of organizing and organized hemorrhagic masses—numerous giant-cells covering entire microscopic field, and occupying vascular spaces.

The practically constant findings in numerous instances of a greatly increased number of giant-cells in areas of recent and ancient hemorrhage lead to the assumption that probably herein lies a great attraction and stimulus for giant-cell formation, and the opportunity for the performance of their function as scavengers. This structure, perhaps,

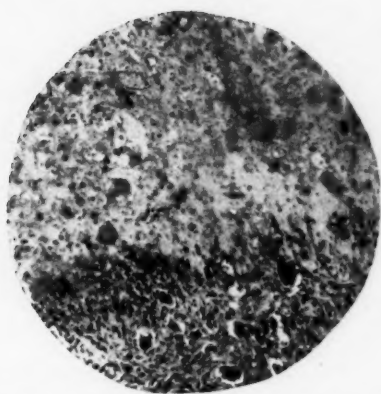


FIG. 1.—Chronic (proliferative) hemorrhagic osteomyelitis. Taken from an area in lesion showing cellular necrosis. Note absence of scavenger giant-cells in necrotic area (low power).

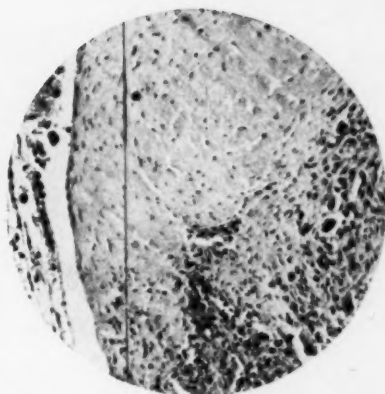


FIG. 2.—Chronic (proliferative) hemorrhagic osteomyelitis. Shows marked fibrosis and fibrosing granulation tissue. Note few scavenger giant-cells, and none where marked fibrosis is apparent (low power).

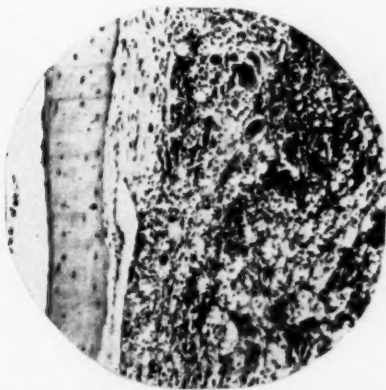


FIG. 3.—Chronic (proliferative) hemorrhagic osteomyelitis. Taken from an area adjoining bone surface. Note heterogeneous cellular picture (low power).

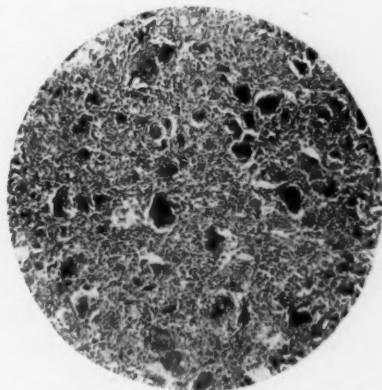


FIG. 4.—Chronic (proliferative) hemorrhagic osteomyelitis. Section taken from heart of hemorrhagic mass. Note scavenger giant-cell content (low power).

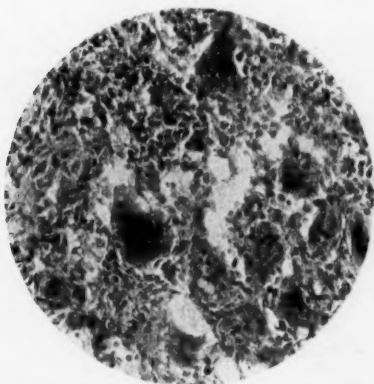


FIG. 5.—Chronic (proliferative) hemorrhagic osteomyelitis. High power picture taken from same section as Fig. 4, to show in detail scavenger giant-cells.

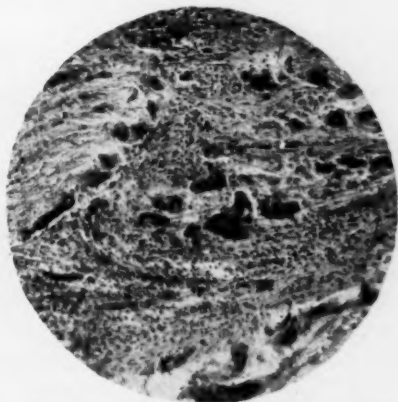


FIG. 6.—Experimentally produced lesion simulating so-called giant-cell sarcoma. Note scavenger giant-cells in granulation tissue cellular picture, intertwined in which may be seen gauze fibres (low power).

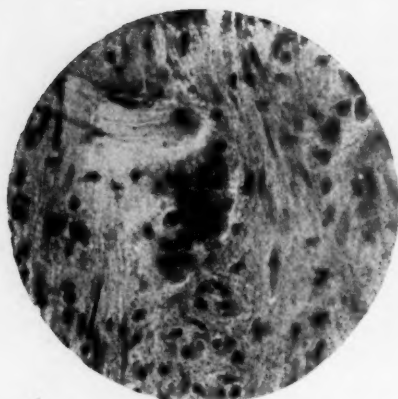


FIG. 7.—High power showing character of scavenger cell seen in Fig. 6.

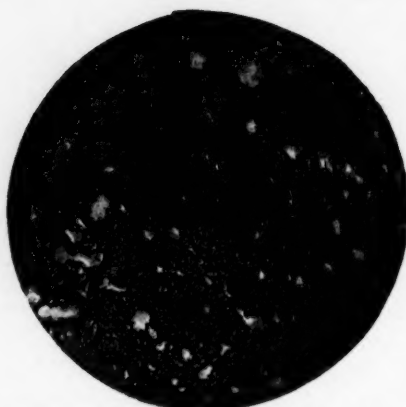


FIG. 8.—True neoplastic growth, a fibrosarcoma of bone, low grade malignancy, showing the giant-cells of scavenger type similar to those of chronic (proliferative) hemorrhagic osteomyelitis, and to the experimentally produced lesion seen in Figs. 6 and 7 (low power).



FIG. 9.—High power picture, fibrosarcoma, low grade malignancy, showing scavenger giant-cell. Taken from same case as Fig. 8.

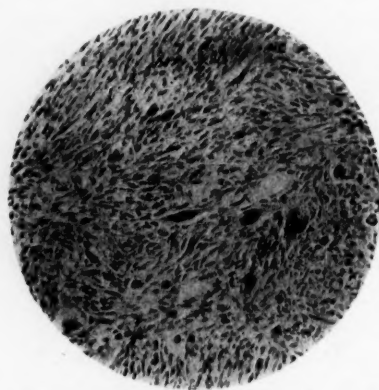


FIG. 10.—True neoplastic growth. Fibrosarcoma of bone, highly malignant. Note the absence of scavenger giant-cells and presence of true tumor giant-cells (low power).

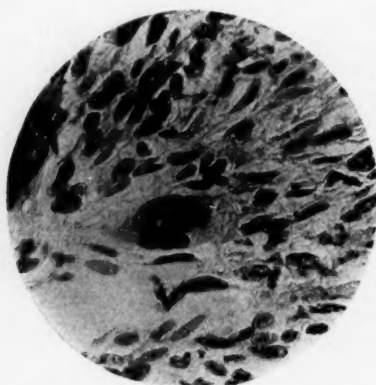


FIG. 11.—High power picture of same tumor as shown in Fig. 10. Note cellular disarrangement and nuclear distortion in giant-cell.

SIGNIFICANCE OF GIANT-CELLS IN BONE LESIONS

offers a greater stimulus than the presence of lime salts from disintegrated bone, as suggested by Mallory. Many of the cells contain pigment.

In papers published in 1912 and 1913, the writer first called attention to the inflammatory origin and chronic character of lesions in the long bones, generally described as medullary giant-cell sarcoma, myeloid sarcoma, myeloma, medullary giant-cell tumor. Subsequent papers published in 1914 and 1915 added further confirmation of the earlier view. Accumulated evidence, study and experimental investigation, add proof to our conclusions previously announced that the lesion does not belong to the neoplastic group. The affection must be regarded as the product of an inflammatory reaction.

The presence of numerous giant-cells within the pathologic mass and upon which great stress has heretofore been made as evidence of neoplastic growth is really the index of a mild inflammatory process. No proof has ever been given that the giant-cells, *per se*, have any effect upon true tumor growth. Abundant evidence is to be had regarding their connection with processes of a mild inflammatory character. It is only necessary to bear in mind that the pathology of a localized so-called rarefying osteitis gives a picture similar to the early stage of what has been named giant-cell sarcoma.

"Rarefying osteitis" is described by Delafield and Prudden as follows: "When this form of inflammation occurs in cancellous bone tissue the marrow is red or gelatinous and the bony septa disappear altogether, so that in extreme cases there may be, instead of cancellous bone, a mass of granulation tissue."

It is not difficult, indeed it is quite easy, to experimentally produce a lesion in the long bones that exactly resembles a so-called medullary giant-cell sarcoma, or tumor, both in its gross and histologic aspects. The method is carried out as follows: Under careful aseptic surgical technic, an opening is made through tissues into cancellous bone, preference being given to the lower end of the femur or upper end of the tibia. A portion of cancellous tissue is removed and the cavity thus made loosely filled with sterile material, preferably gauze, or some of the removed cancellous bone may be replaced in the cavity surrounded with gauze. The wound is then closed and sealed. On reopening some weeks or months later a typical picture of so-called giant-cell sarcoma may be presented. Experimental work of this character offers substantial support of the inflammatory origin and progress of these lesions.

Adami and Bland Sutton, recognizing that the so-called medullary giant-cell sarcomata were benign in character, and believing the giant-

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cells they contained were of myeloblastic origin, in later works described the lesion as myeloma. The term myeloma does not seem altogether fortunate, because we already have a well-defined and generally recognized tumor bearing the name that gives its own characteristic picture, quite different from the lesion under consideration. Mallory's evidence that so-called myeloplaxes are of endothelial origin would seem to rule out the term.

Bloodgood, as a result of careful observation, large experience, and exhaustive study of all types of bone lesions, also grasped the fact that malignancy was not a feature of this pathologic process. He suggested the term "medullary giant-cell tumor" in 1912. The term giant-cell tumor, if applicable here, is equally so in other parts of the body where granulation tissue has room to proliferate and spread, and embedded in which alien sterile particles preside.

The presence of granulation tissue masses presupposes an inflammatory process of mild degree. As it seems impossible of proof that the giant-cells have anything to do with tumor growth or tumor formation and all evidence points to their function as scavengers, or foreign body cells, brought forth for a definite purpose, and disappearing when that purpose is fulfilled, it does not seem they may be effectively classed as tumor cells.

Neither can the granulation tissue masses that compose these lesions rightly be termed tumors or neoplasms. The writer desires to emphasize the opinion expressed in earlier papers that this bone lesion should be grouped with the surgical diseases classified as inflammations. From the clinical picture and gross and microscopic pathology it presents, the term "chronic (proliferative) hemorrhagic osteomyelitis" is, perhaps, more exact and correct than the other terms now in use.

In a future paper, the writer will attempt to take up in detail the etiology concerning this particular inflammatory pathologic process. An effort will also be made to bring out more clearly the position that should be assigned to trauma, mild infections, and irritative metabolic changes as factors in its production.

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A COMPOSITE STUDY OF THE CÆLIAC AXIS ARTERY

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THE many vascular variations which are constantly observed in the dissection of adult cadavers show a distinct tendency to group themselves into definite anatomic types. The epoch-making work of Ruge in 1883 contributed greatly to our knowledge of arterial variations. It was his conclusion that these variations tend to fall naturally into distinct groups. Hitzrot's study of the axillary artery, Bean's of the subclavian, and that of the writer on the femoral support Ruge's conclusions.

The first paper on the study of the blood vascular tree presents a consideration of the femoral artery. In this the second paper of the series, a study of the cœliac axis artery is presented. The records which underlie this study were made from student and personal dissections at the Daniel Baugh Institute of Anatomy of the Jefferson Medical College. The dissections of 83 cadavers were recorded; 67 male white, 8 female white, 6 male negro, and 2 female negro.

In the study of the femoral artery, mention is made of the occurrence of numerous minor arterial variations not entirely in accord with the described anatomic types; yet the cases studied show a clear tendency to group themselves into distinct anatomic types. Analogous results are now found in the study of the cœliac axis artery. The classification of the cœliac axis artery is based on the origin and distribution of the gastric, splenic and hepatic arteries. Section A of this paper contains a description of the various types. Section B embraces a description of the gastric, splenic and hepatic arteries and their respective branches. Section C summarizes and discusses the results of the present study.

SECTION A—DESCRIPTION OF TYPES

TYPE I.—This type (Fig. 1) is found in 75 per cent. of the cases classified. It embraces those subjects in which the cœliac axis is the common trunk of origin for the gastric, splenic and hepatic arteries.

In 24 of the cases studied the gastric artery is the first branch of the coeliac axis and it arises eleven times from the coeliac axis close to the aorta. The gastric artery takes origin six times from the summit of the coeliac axis. The splenic artery in two of the cases observed is the first branch of the coeliac axis. In 21 of the subjects classified, the gastric, splenic and hepatic arteries arise from the coeliac axis at the same level.

The celiac axis varies in length from 1 to 3 cm. and is not infre-

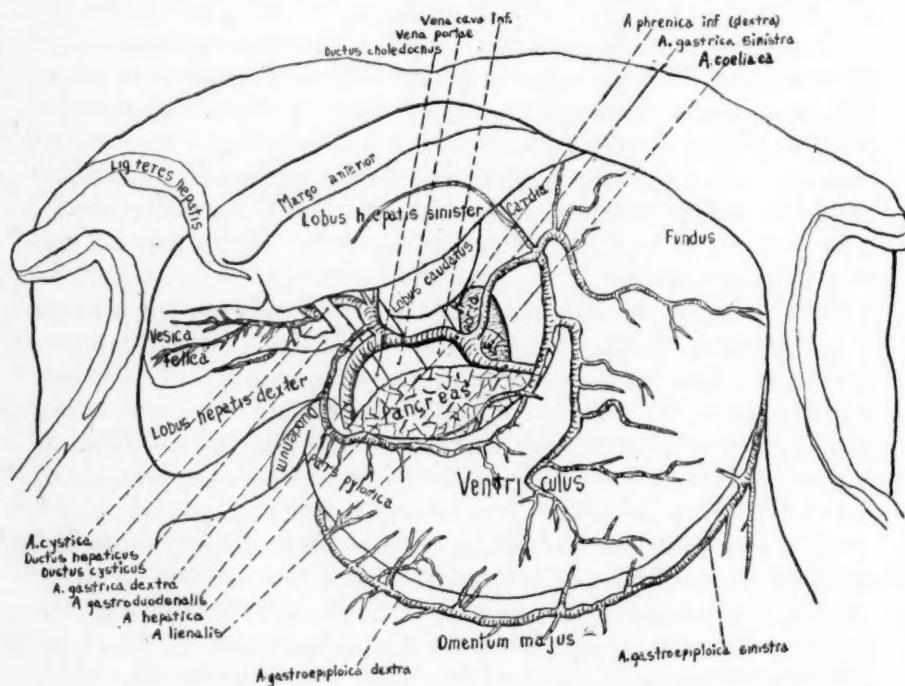


Fig 1.

FIG. 1.—This arrangement of the branches occurs in seventy-five per cent. of the cases classified.

quently partly covered at its origin by the diaphragm. It is worthy of note that in eight subjects of this group both the coeliac axis and its branches are poorly developed; these subjects present no additional vessels from the adjacent arteries to compensate for this apparent deficiency in blood supply. There are in this type (Fig. 1) 53 male white, 4 female white, 3 male negro, and 1 female negro subjects. This is the type which is described in the German, English and French anatomical text-books most universally used.

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TYPE 2.—This type (Fig. 2) is present in 15 per cent. of the cases classified. In this group the hepatic and splenic arteries both arise from the cœliac axis artery. The gastric artery occurs as a separate branch directly from the abdominal aorta, and in every case observed it is cephalic to the origin of the cœliac axis. The cœliac axis artery divides at its summit into the splenic and hepatic arteries. There are in this group 11 subjects in all—9 male white, 1 female white, and 1 male colored.

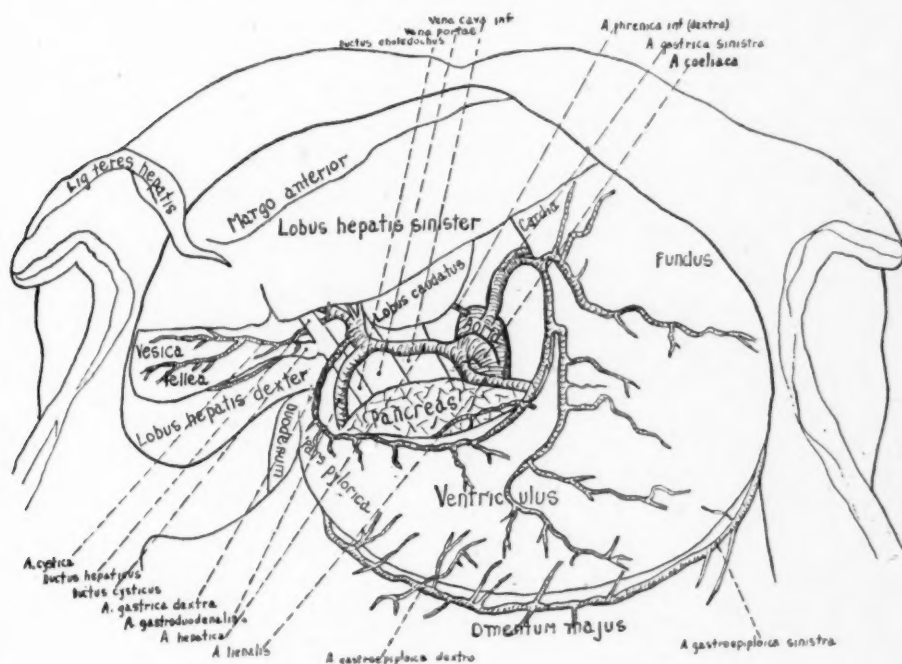


Fig 2

FIG. 2.—This type occurs in fifteen per cent. of the cases classified.

TYPE 3.—This type (Fig. 3) is present with slight variations in 6 per cent. of the subjects studied. In this type the gastric and hepatic arteries take origin from the cœliac axis artery. The splenic artery arises as a separate branch from the abdominal aorta. The hepatic artery in 3 subjects of this group is represented by two vessels each of which has a separate origin from the cœliac axis artery. There are of this type 5 subjects; 3 male white, 2 female white, and 1 male negro.

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TYPE 4.—This type (Fig. 4) occurs in 4 per cent. of the cases classified. The celiac axis in this group is the trunk of origin for the gastric and splenic arteries. The hepatic artery occurs as a separate branch directly from the abdominal aorta.

SECTION B—DESCRIPTION OF BRANCHES

A. Gastrica Sinistra.—This vessel is the smallest of the three branches of the celiac axis. It, however, is considerably larger than the right gastric (pyloric) artery. It arises in 15 per cent. of the cases observed as a separate branch of the

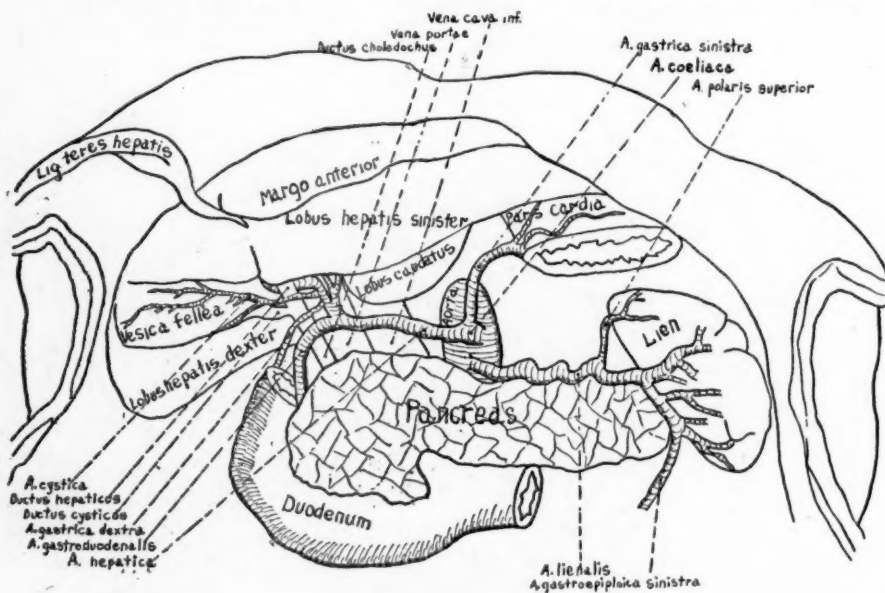


Fig. 3.

FIG. 3.—This arrangement of the branches occurs in six per cent. of the subjects studied.

abdominal aorta, and its point of origin is always cephalic to the origin of the celiac axis artery. As it courses between the two layers of the lesser omentum, along the lesser curvature of the stomach, it is found in 35 per cent. of the subjects studied as two parallel stems. The site of division of the left gastric artery into a double vessel varies from one and a half to three cm. from its origin. In no case observed is the left gastric artery present as a double vessel at its origin. It occurs as a single vessel along the lesser curvature of the stomach which gives origin to the branches passing downward over both surfaces of the stomach in 65 per cent. of the cases classified. The left gastric artery occurs six times in a trunk common with the hepatic. In two of the subjects observed, it is present in a trunk common with the splenic artery. In one subject it takes origin from the abdominal aorta in a trunk common with the hepatic and superior mesenteric arteries; the splenic artery arising as a separate branch directly from

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the aorta and taking a circuitous route looping around the left gastric artery to gain its usual site and distribution.

The œsophageal rami are unusually large and well marked in 30 per cent. of the subjects studied. In three bodies observed, they are found as branches of the right inferior phrenic, and four times as branches of the hepatic branch of the left gastric. The cardiac rami vary in number and size and are usually not as well marked as the œsophageal rami. In 8 of the cases classified they are present as branches of the hepatic branch of the left gastric.

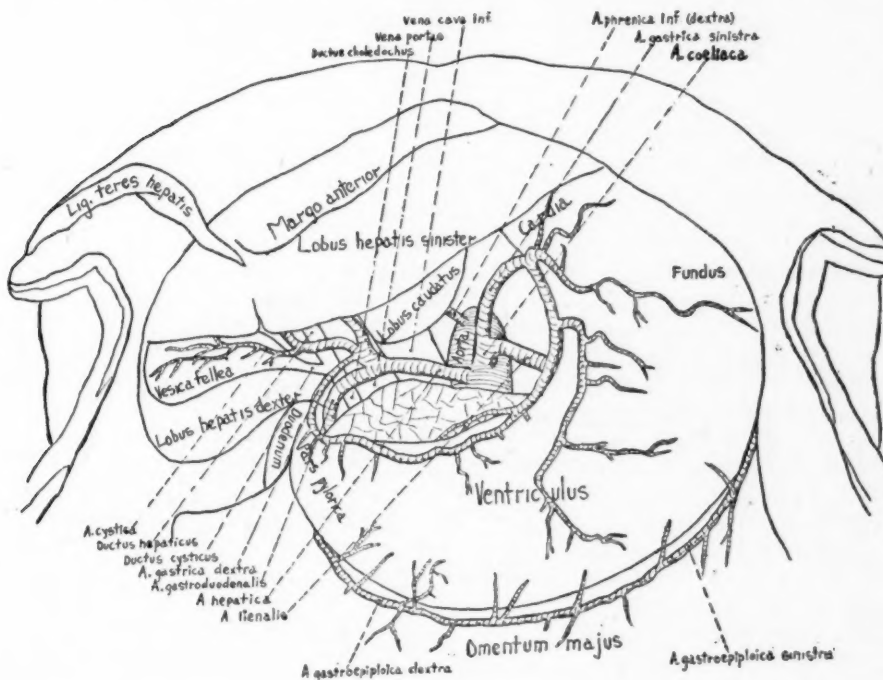


Fig 4.

FIG. 4.—This type is present in four per cent. of the cases classified.

A hepatic branch of the left gastric artery is found present in 35 per cent. of the subjects studied. This vessel varies both in size and in its anatomic distribution. It passes upward between the two layers of the lesser omentum to the inferior (visceral) surface of the left lobe of the liver in 16 of the cases observed. It is distributed as a branch to the transverse (portal) fissure 11 times and 3 times to the posterior surface of the liver and the œsophagus. It not infrequently gives origin to a number of twigs to the cardiac end of the stomach. This vessel in those cases in which it gains the portal fissure of the liver and in its distribution constitutes a left hepatic artery does not, however, replace the left hepatic which is present and well developed.

A. Lienalis (Splenic).—This vessel is the largest of the three branches of

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the cœliac axis. The splenic artery arises from the cœliac axis in 92 per cent. of the subjects studied. It occurs 6 times as a separate branch directly from the aorta. In 15 per cent. of the cases classified, it takes origin from the abdominal aorta in a common trunk with the hepatic. In two bodies observed it is present in a common trunk with the left gastric.

In 67 per cent. of the cases classified this vessel is large and presents numerous tortuosities as it pursues its more or less transverse course from right to left along the upper border of the pancreas accompanied by the underlying splenic vein to gain the spleen. In 33 per cent. of the cases classified, this vessel is straight or only slightly tortuous. The splenic artery at its termination divides into two or three large terminal trunks, which break up into 6 to 10 branches before they enter the spleen. There are three terminal branches in 72 per cent. of the subjects classified; A. polaris superior, A. terminalis superior, and A. terminalis inferior; the two latter vessels enter the hilum of the spleen. In 28 per cent. of the subjects there are two terminal branches; A. terminalis superior and A. terminalis inferior, the A. polaris superior arising from the trunk of the splenic or as a branch of the A. terminalis superior. The termination of the splenic artery usually occurs at the border of the middle and lower thirds of the spleen. The splenic artery breaks up into its terminal branches at a distance varying from one to seven cm. from the spleen. In 10 per cent. of the cases studied, the division of the splenic artery into its terminal branches is from 6 to 7 cm. from the spleen.

In 4 of the cases studied, the splenic artery in addition to its numerous pancreatic rami gives off at its origin an unusually large branch which is distributed to the head of the pancreas.

A. Gastro-epiploica Sinistra.—Its point of origin from the splenic artery is variable. The most frequent origin of this vessel is as a branch of the cephalic terminal trunk of the splenic artery. It occurs 12 times as a branch of the caudal terminal trunk. In 14 of the cases classified, this vessel arises from the trunk of the splenic artery before it breaks up into its terminal branches. In 6 of the subjects studied, it arises from the middle of the trunk, and in one instance within two cm. of the cœliac axis artery. In 5 of the subjects observed, the splenic artery gives origin to a large branch which courses cephalically and is distributed to the left lobe of the liver. The middle cœlic artery in two of the cases studied occurs as a branch of the splenic.

A. Hepatica.—This vessel is the most variable of three branches of the cœliac axis, and in the adult is intermediate in size between the splenic and gastric. It occurs as a branch of the cœliac axis artery in all but three of the subjects studied. In the latter it arises as a separate branch directly from the abdominal aorta. In 15 per cent. of the cases classified, it takes origin in a common trunk with the splenic artery. It arises 6 times in a trunk common with the gastric artery. In one case observed, it is found present in a common trunk with the gastric and the superior mesenteric arteries.

The hepatic artery is represented as a double vessel in 11 per cent. of the cases studied, i.e., its two terminal rami—ramus dexter and ramus sinister—arise as separate branches directly from the cœliac axis artery. The hepatic artery arises as a single vessel in 89 per cent. of the cases observed and it presents great variation at the point of division into its two terminal branches. This division occurs six times within one and a half cm. from its origin and the branches pass from left to right along the free border of the lesser

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omentum as two parallel stems. In 22 per cent. of the cases studied, this division occurs at the site of origin of the gastroduodenal artery. The most frequent point of division is within two to three cm. of the portal (transverse) fissure of the liver. In 9 of the cases classified, both of the terminal branches again divide into two or more stems at or close to their origin as they ascend to gain the liver. The right hepatic artery usually passes dorsad of the hepatic duct. In a small number of subjects, it is found ventral to the hepatic duct.

A. Gastrica Dextra (Pyloric).—This vessel in every case observed is smaller than the left gastric artery. The most frequent origin of the pyloric artery is as a branch of the hepatic lateral to the origin of the gastroduodenal artery. In 22 per cent. of the cases studied, it occurs as a branch of the gastroduodenal artery. It is found four times as a branch of the right hepatic artery and three times as a branch of the left hepatic. The pyloric artery arises in two of the cases classified, as a separate branch directly from the cœliac axis artery. In one case observed, it is present as a branch of the superior mesenteric artery. In 21 per cent. of the subjects classified, this artery is represented as two parallel vessels which arise from the trunk of the hepatic and continue between the two layers of the lesser omentum along the lesser curvature of the stomach as two vascular arches.

A. Gastroduodenalis.—This artery presents few variations in its origin. Its most frequent origin is as a branch of the hepatic artery, before the latter divides into its terminal branches. In every case observed its origin is medial to the origin of the pyloric artery. In three of the cases classified, it occurs as a branch directly from the cœliac axis.

In almost every subject observed, the right gastro-epiploic artery is of greater length and calibre than the superior pancreaticoduodenal artery. The superior pancreaticoduodenal artery occurs in all but three of the subjects studied as a branch of the gastroduodenal. In the latter three subjects it is present as a branch of the hepatic artery. The right gastro-epiploic artery is found in all but four of the cases classified as a branch of the gastroduodenal, where it occurs as a branch of the hepatic artery.

A. Cystica.—The cystic artery shows considerable variation in size, origin and relation. Its size is usually proportionate to the size of the gall-bladder. This vessel occurs most frequently as a branch of the right hepatic artery. In those cases observed in which the right hepatic artery breaks up into two or more stems in its course to the portal fissure, the most lateral twig gains the gall-bladder and becomes the cystic artery. The right hepatic artery in 40 per cent. of the cases studied closely adheres to the dorsal surface of the cystic and hepatic ducts near their point of union, at which site the cystic artery frequently arises. In 8 per cent. of the subjects this vessel occurs as a branch of the hepatic artery before it breaks up into its two terminal branches, and as it ascends laterally towards the gall-bladder, it passes ventrad of the hepatic duct and ventrocephalad of the cystic duct to gain its usual site and distribution. In one subject the right hepatic artery is distributed entirely as the cystic. In 11 per cent. of the cases classified, the cystic artery occurs as a branch of the left hepatic. The cystic artery is usually cephalad and ventrad of the cystic duct. In 3 of the cases observed, this vessel is caudal to the cystic duct; and in 2 of the subjects it has a position lateral to the cystic duct. The cystic artery in 3 of the cases studied is present as a separate branch directly from the superior mesenteric (Fig. 5D). It is found three

times as a branch of the gastroduodenal artery. In 8 per cent. of the cases classified, the cystic artery is represented by two parallel vessels which arise separately from the right hepatic, except in 2 of these subjects in which they arise from a hepatic branch of the superior mesenteric (Fig. 5 C) and pass ventrad and cephalad to the cystic duct in their course to the gall-bladder. This additional cystic artery arises in two subjects observed, directly from the aorta

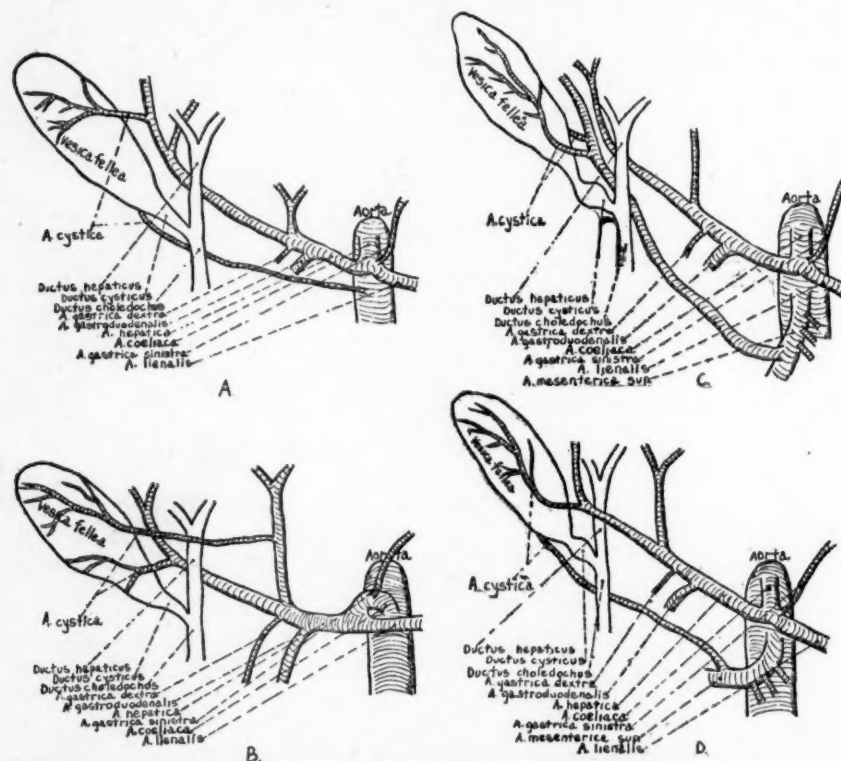


FIG. 5.—These drawings illustrate unusual variations in the occurrence of the cystic artery as a twin vessel. A, the additional cystic artery arises directly from the abdominal aorta and is found in three of the eighty-three subjects studied. B, the additional cystic artery occurs as a branch of the left hepatic and courses ventrad of the hepatic duct and right hepatic artery. This occurs in only one subject. C, both cystic arteries arise as branches of a hepatic branch of the superior mesenteric artery. This is found in two of the subjects studied. D, the additional cystic artery is present as a branch directly from the superior mesenteric artery. This variation occurs in three of the subjects studied.

(Fig. 5 A) and courses dorsad to the common bile-duct and is caudal to the cystic duct as it reaches the gall-bladder.

Rossi e Cavi in a study of 96 subjects found the cystic artery present as a twin vessel in 11.5 per cent. of the subjects; Belou in a study of 150 subjects in 19 per cent., and Branco in a study of 50 subjects, in 12 per cent.

A. Accessoria Hepatica.—Mention is made in the description of the gastric and splenic arteries of the occurrence of the accessory hepatic artery. In 35 per cent. of the cases classified, it occurs as a branch of the left gastric artery and in 5 subjects as a branch of the splenic artery.

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This vessel occurs in 15 per cent. of the cases as a branch of the superior mesenteric artery. It arises in a trunk common with the superior mesenteric or as a branch of the superior mesenteric from 1 to 3 cm. of its origin. The usual distribution of this vessel is as the right hepatic artery; in only two of the subjects is the anatomic distribution of this vessel as a left hepatic. The accessory hepatic artery ascends in its course to gain the liver, passes behind the stomach and pancreas, dorsal and medial to the common bile-duct, directly dorsal to the site of the union of the cystic and hepatic ducts, and at the portal fissure it is lateral to the hepatic duct and portal vein. In 4 of these subjects the gastroduodenal artery occurs as a branch of this vessel and in 3 of the subjects it gives origin to the pyloric and gastroduodenal arteries. This accessory hepatic vessel breaks up into two or more stems, one of which becomes the cystic artery or gives origin to the latter. In 3 of these cases the hepatic artery arises in its entirety from the superior mesenteric and pursues a course as outlined above.

A. Phrenica Inferior.—Both phrenic arteries arise 5 times as separate branches from the cœliac axis artery. In 2 of the cases studied, they arise from the cœliac axis artery in a common stem. The left inferior phrenic artery occurs 6 times as a branch directly from the cœliac axis, in 2 of which subjects this vessel gives off a number of small pancreatic rami. The right inferior phrenic artery is present in three of the cases classified as a branch of the cœliac axis.

SECTION C—SUMMARY AND DISCUSSION

(1) A comparison of the types of the arteria cœliaca demonstrates the unusual predominance of Type I. This arrangement is present in seventy-five per cent. of the subjects and is the type described in all standard anatomical text-books. Type II occurs in fifteen per cent. of the cases and Types III and IV in ten per cent. The occurrence of Type I in so large a number of the cases classified stands out as one of the most interesting results of this study.

(2) This study embraces the dissection of eighty-three cadavers, sixty-seven male white, eight female white, six male negro, and two female negro. No relation of the branches to age could be drawn as there were only adults in this series. In the study of the femoral artery the negro subjects presented a greater proportionate number of variations and anomalies than the whites. The number of negro subjects in this series is, however, too small to present an analogous study.

(3) The left gastric artery occurs more frequently as a branch of the abdominal aorta than the splenic or hepatic arteries. The left gastric artery in thirty-five per cent. of the subjects studied is represented along the lesser curvature of the stomach as two parallel vessels. The right gastric artery (pyloric) appears as two parallel vessels in 21 per cent. of the cases studied.

The splenic artery frequently presents numerous tortuosities and is of unusually large calibre. In 30 per cent. of the cases classified, this vessel pursues a straight or only slightly tortuous course. The hepatic artery occurs as a double vessel in 11 per cent. of the cases studied. Each branch has a separate origin from the cœliac axis. The cystic artery usually arises from the right hepatic and in 8 per cent. of the subjects it appears as a twin vessel. It is usually ventrocephalad of the cystic duct.

(4) An accessory hepatic artery occurs in 35 per cent. of the cases classified as a branch of the left gastric; in 15 per cent. of the subjects as a branch of the superior mesenteric, and 5 times as a branch of the splenic. In one subject the hepatic, superior mesenteric and left gastric artery arise from the abdominal aorta in a common trunk. The hepatic artery arises three times in its entirety from the superior mesenteric. In 25 per cent. of the cases studied, the cœliac axis gives off only two branches—in 15 per cent. it is the hepatic and splenic arteries, in 6 per cent. the hepatic and the gastric, and in 4 per cent. the splenic and the gastric. Rossi e Cavi in a study of 102 subjects found the cœliac axis artery absent in 2 of the subjects; its branches, the gastric, splenic and hepatic arteries arising independently from the abdominal aorta.

(5) An unusually interesting anomaly occurs in two of the cases observed, the so-called "truncus cœliaco-mesenterica" (Ratke and Meckel). The cœliac axis and the superior mesenteric arteries take origin in a common trunk. This is an entirely normal condition in the anuria, some of the chelonia, and some of the mammalia (Keibel and Mall). Tandler interprets this as a result of the persistence of the large primitive ventral anastomosis between the early segmental cœliac axis and superior mesenteric groups. This longitudinal anastomosis is the trunk of origin for the gastric, splenic and hepatic arteries. The main part of the trunk is the superior mesenteric and as this is the stronger vessel it in this way takes over the branches which usually arise from the cœliac axis. The presence of a partial persistence of this longitudinal anastomosis explains the occurrence of the origin of the hepatic artery or an accessory hepatic artery from the superior mesenteric.

(6) The contention of Ruge in 1883 that arterial variations group themselves into distinct anatomic types is supported by the studies of Hitzrot, Bean and those of the writer. The descriptions of the arterial trunks as contained in standard anatomical text-books conform usually to but one type. Composite studies of the individual arterial trunks,

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each study embracing the investigation of a large number of cadavers, disclose that the variations found allow of a natural grouping into distinct anatomic types.

The usual and accepted conventional opinion, that whenever a vessel occurs which is at variance with the classic text-book description it is an anomaly, needs to be revised. In studying a large number of arteries of one of the large arterial trunks of the body, certain variations are found to occur with sufficient frequency to justify the establishment of distinct groups. At times variations occur which differ so widely from the normal types of the vessel that they cannot be classified; these alone should be termed anomalous.

This interesting phase of anatomical study—the establishment of anatomic types, simplifies and makes more easy of comprehension all the variations of the large arterial trunks of the body. A knowledge of the types of the larger arterial trunks will aid the surgeon in avoiding troublesome and dangerous hemorrhage that otherwise could not be averted, and it is incumbent that he move slowly in operative procedures until he has determined the exact anatomy of the part. The constant variations in size, calibre and number of the branches may be an etiological factor in the production of certain pathologic conditions.

Professor J. Parsons Schaeffer, head of the Department of Anatomy of the Jefferson Medical College, at whose suggestion these studies were begun, kindly permitted me to make full use of all the material in his department and I take this opportunity of expressing my thanks for his interest, attention and criticism in this work.

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A COMPARISON OF THE PERMANENCE OF FREE TRANSPLANTS OF BONE AND CARTILAGE

AN EXPERIMENTAL STUDY

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(From the Hunterian Laboratory of Experimental Surgery)

Introduction.—The appearance in the last year or two of a number of clinical papers still strongly advocating the transplantation of bits of tibia or sections of bony ribs for the relief of saddle nose, has interested me considerably. From the results of my experimental work on cartilage transplantation, and also on bone transplantation, I had concluded that cartilage was by far the best material to use in such cases.¹ My clinical experience with transplanted cartilage had also been so satisfactory in the treatment of saddle nose and in rhinoplastic operations, that I had entirely discontinued the use of any other substance. However, as there seemed some difference of opinion as to the relative stability of bone and cartilage transplants, I carried out the following procedures in order to clear up the matter, at least from an experimental standpoint.²

The experiments were carried out on dogs, and the ordinary run of laboratory animals was used. Ether anæsthesia was used in each experiment.

Technic.—The part was shaved, washed with green soap and water, followed by alcohol and then with ether. Fine black silk was the ligature and suture material used throughout. The healing was *per primam* in each experiment reported.

In order to produce conditions which would be somewhat similar to those in actual clinical practice, I transplanted the cartilage and bone so that one extremity of the transplant was in close contact with a denuded portion of a membranous bone, while the remaining portion of the transplant extended into the soft parts.

¹ Davis, J. S.: The Transplantation of Rib Cartilage into Pedunculated Skin Flaps. An Experimental Study. J. H. H. Bull., vol. xxiv, April, 1913, p. 116; also Davis, J. S., and Hunnicutt, J. A.: The Osteogenic Power of Periosteum; with a Note on Bone Transplantation. An Experimental Study. J. H. H. Bull., vol. xxvi, March, 1915, p. 69.

² I take this opportunity of thanking Dr. LeR. N. Fleming for his aid in the operative experiments.

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The cartilage was obtained from the cartilaginous ribs, which is the usual clinical source of supply. The spongy bone was obtained from the ribs, and the hard bone from the fibula. Auto transplants only were used.

Experiments.—The experiments were grouped as follows: (1) Cartilaginous rib with perichondrium, and bony rib without periosteum. (2) Cartilaginous rib with one-half perichondrium, and bony rib without periosteum. (3) Cartilaginous rib without perichondrium, and bony rib without periosteum. (4) Cartilaginous rib without perichondrium, and bony rib with one-half periosteum. (5) Fibula with its periosteum, and fibula denuded of its periosteum.

Typical Experiment.—Series D1. Mongrel dog, about two years old.

Operation.—A section of bony rib was removed subperiosteally from the right side, and also a section of cartilaginous rib with its perichondrium. Through a short incision in the temporal muscle, the periosteum of the parietal bone was button-holed, and a small pocket was burrowed beneath it. Into this pocket the bevelled end of the transplant was placed, so that the graft came in close contact with the denuded bone. The rest of the transplant was buried in the temporal muscle, which held it firmly in place. Both transplants were 2 cm. long. In each experiment the bony rib was placed on the right side and the cartilage on the left side of the skull.

Group 1. The Transplantation of Cartilage with Its Perichondrium Intact, and Rib Without Periosteum. Summary.—Six experiments were done. The specimens were examined 24, 25, 85, 223, 576 and 582 days after operation. In each instance the cartilage was found apparently intact, and 2 cm. in length. After 24 and 25 days there was little change in the length of the bone, although beginning absorption was noted. In the 85 day specimen there was rather a dense outgrowth of bone from the skull about the impinging portion of the transplant. This gave the impression of being rather excessive, when compared with the other specimens, and might have been caused by a slight localized infection. There was also marked evidence of absorption, although the bone was still 2 cm. in length. After 223 days no bone whatever could be found, either by X-ray or by careful dissection. In the 576-day specimen a very small spicule of bone was found projecting from the skull, this bone was pitted and was very irregular in shape. It may have been new bone from the skull, rather than the remains of the transplant. Its greatest measurements were 2 mm. in length and breadth and 1 mm. in thickness. In the 582 day specimen a tiny irregular spicule of bone, not more than .5 mm. long, projected from the parietal bone.

This group seems to show that under exactly the same conditions transplanted cartilage and spongy rib bone behave quite differently. The cartilage retains its original size, while the bone, on the other hand, in the shortest experiment shows a tendency to absorption, and this progresses as time goes on. It is difficult to say why the bone in the 223-day experiment should have entirely absorbed, while evidences

remained of the transplant in other experiments observed for more than twice that length of time.

Group 2. Cartilage with One-half of Its Perichondrium (Lengthwise) and Rib Without Periosteum. Summary.—Four experiments were done. The specimens were examined 44, 125, 374, and 505 days after operation. In each instance the cartilage was found to be the same length as when transplanted. After 44 days the bone was a scant 2 cm. long and showed evidences of absorption. After 125 days the bone was 1 cm. long, very thin and nearly absorbed. After 374 days only a thin spicule of bone, 8 by 2 mm., remained. After 505 days a very thin fragment, 7 by 2 mm., remained.

Group 3. Cartilage without Perichondrium, and Rib Without Periosteum. Summary.—Two experiments were done. The specimens were examined 165 and 332 days after operation. In both experiments the cartilage was found to be 2 cm. long and apparently intact. In the 165 day specimen the bone had entirely disappeared. After 332 days the bone was 7 by 1 mm., being thin and flexible.

These groups again emphasize the tendency of bone to be absorbed, and of cartilage to retain its original length and thickness, even though partially or wholly denuded of its perichondrium. It is impossible to say why one of the rib transplants had disappeared in 165 days, while thin fragments of bone, showing all the signs of degeneration, were found 332, 374 and 505 days after transplantation.

Group 4. Cartilage without Perichondrium and Rib with Strip of Periosteum. Summary.—Four experiments were done. The specimens were examined 13, 26, 49, and 56 days after operation. The cartilage remained unchanged in each experiment. In the 13 day experiment there was no change in the size of the bone. In the 26 and 56 day experiments the bone, which was 2 cm. long when transplanted, was found to be 1.6 cm. long, and in the 48 day experiment it was 1.4 cm. long.

This again shows the tendency of bone to absorb, in spite of the presence of a strip of undisturbed periosteum, and the cartilage to be unchanged, even though the perichondrium is removed.

Group 5. A Section of Fibula, with Periosteum, and a Similar Section Without Periosteum, were Transplanted as in Previous Experiments. Summary.—Three experiments were done. The sections of fibula to be compared were of equal length, and varied between 1.4 and 1.8 cm. in the different experiments. The specimens were examined 305, 328 and 388 days after operation. In each experiment the section of fibula without periosteum had been absorbed. In the 305 day experiment the section of fibula with periosteum, which was originally 1.8 cm. long, measured 5 mm. long by 1 mm. at its widest, and was thin, irregular and flexible. In the 328-day experiment the transplant, which was covered with periosteum and which was originally 1.75 cm. long, measured 8 mm. in length by 1 mm. in width, and was thin and flexible. After 388 days the section of fibula covered with periosteum, which was originally 1.4 cm. long, measured 7 mm. in length by 1 mm. in width, and was thin and flexible.

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The group shows that the hard bone of the fibula is absorbed, as well as the more spongy bone of the rib. It also confirms experiments previously reported, which showed that a bone covered with periosteum is more resistant to absorption than denuded bone, but that in time it also will be absorbed.

Remarks.—It has been often demonstrated that free bone, either with or without periosteum, when transplanted into soft parts, without any particular function, will eventually be absorbed. From these experiments this also seems to apply to free bone transplants with one end in contact with denuded bone, as in no instance, where any considerable time elapsed, did the transplant seem to hold its own against absorptive processes. In the experiment of longest duration only a tiny spicule of bone remained projecting from the parietal bone, and it is obvious that this remaining spicule of bone would have been insufficient had the original transplant been used as a supporting framework.

I found in a previous series of experiments that when a pedunculated flap of periosteum, with a thin layer of bone, was raised and the soft parts were sutured beneath, there was at first a marked thickening with production of new bone, but that in time this thickened portion was absorbed, and the length of the bone-periosteal flap much reduced. If this is the fate of a flap which is pedunculated, it is much more likely that absorption will take place in a free bone graft, which may, or may not, impinge firmly against denuded bone at one end.

My experience with bone transplantation leads me to believe that if new bone should be formed, it would never be long enough or strong enough to give proper support to the part.

The cartilage in each experiment showed no signs of absorption, and was normal in appearance, even when entirely denuded of perichondrium. In no instance was there any increase in the length of the cartilage.

The free end of the cartilage had become rounded in all the experiments. The end of the cartilage in contact with the skull was firmly adherent to it in some experiments, while in others it was slightly movable.

The healing was reactionless, and the cartilage did not act as a foreign body. The measurements of the cartilage differed very little, if at all, from those taken at the time of transplantation. On section, the cartilage appeared normal and seemed well nourished.

In several experiments the transplants became dislodged from con-

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tact with the skull, and were found in the adjacent soft parts, but in every instance the cartilage was unchanged, while the bone had either disappeared or showed signs of absorption, the extent of which depended on the length of time following transplantation.

Microscopic examination of the transplanted cartilage when compared with the control sections, showed remarkably little change in the condition of the cartilage. The most striking feature was the absorption of the central areas of calcification. The cells were for the most part in good condition, and showed well stained nuclei. Some of the cells of the outer layers varied in staining properties, but the whole impression was that of living cartilage. It is not possible to say whether new cells had been formed, although in some of the sections longest transplanted there seemed very active groups of cells in the central areas. The presence or absence of perichondrium seemed to have little effect on the nourishment of the cartilage cells.

Cartilage is flexible and thus is less liable to subsequent fracture; it can be easily cut and shaped into any desired form; it is no more difficult to obtain than bone, and a large supply is always available. Any one of these advantages, it seems to me, would suggest the use of cartilage rather than bone for the supporting material in transplantation for the correction of saddle nose, and also for the framework in rhinoplastic operations.

Conclusion.—These experiments show that transplants of free cartilage are unchanged during the length of time under observation, while free bone transplants under exactly the same conditions had either disappeared or showed marked degenerative processes.

STUDIES ON PAGET'S DISEASE OF THE NIPPLE AND ITS EXTRAMAMMARY OCCURRENCE*

REPORTS OF EIGHTEEN CASES PERSONALLY INVESTIGATED

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PAGET'S disease of the nipple is of interest to clinicians and pathologists because it is still to be decided whether it is cancer or a precancerous condition. Although many, especially clinicians, at present are inclined to believe it precancerous, the basis for their deduction is not yet sufficiently decisive. Moreover, some authors believe that the term is used to designate various different affections. Napier described a long-continued eczematous condition which healed without cancerous formation. He believed that at least two conditions have been included under the term "Paget's disease"—the one, a true cancerous condition, the other a simple chronic eczema. According to Besnier, there are several forms of Paget's disease: in the first, there is induration and retraction of the nipple, and operation should be undertaken at once; in the second, there is no induration or retraction of the nipple, and immediate intervention is not necessary. Czerny expressed his opinion in Hanser's dissertation: "Überhaupt ist dieser Name eine ganz vage Bezeichnung geworden: denn es besteht eine grosse Differenz zwischen einzelnen Berichten und auch in dem (den meisten Beziehungen), einheitlichen Krankheitsbilde von Paget selbst, dass man ja schliesslich ebensogut jede Erkrankung der Warzen wie des Warzenhofes so benennen könnte—einerlei welcher Natur sie ist, einerlei ob ihr ein Drüsenkrebs der Mamma folgt oder nicht." Depage observed one glandular cancer of the breast which made its way through the milk-ducts into the epidermis and caused an eczematous condition, but with no coccidia-like bodies in the sections. This case he called "pseudo-Paget disease." Malinowski reported a case of colloid cancer of the breast followed by an eczematous alteration of the skin due to retrograde metastasis. Jopson and Speese noticed an early case of diffuse, scirrhous carcinoma associated with a dry and limited eczema of the nipple which they concluded should be distinguished from true precancerous Paget's disease.

In this article I shall discuss only cases of genuine Paget's disease

* This material was obtained and studied partly in Prof. T. Kondoh's Clinic (the Imperial University of Tokyo) and partly in Dr. W. C. MacCarty's pathological laboratory (Mayo Clinic, Rochester, Minn.).

not preceded by tumor in the deep layers. The details of each case will be given.

Nomenclature.—Paget's disease has been variously designated according to various opinions in regard to its nature. Besnier described it as "Epitheliomatose eczematoïde de la mamelle." Thin called it "Malignant papillary dermatitis." Lang called it "Dermatosis epithelialis (degenerativa) circumscripta eczematiformis," Terzaghi and Campana, "Eczema psoriasiformis," and Piffard, "Mammalitis maligna." Hirschel suggested the name of "Krebs-eczema der Brust." The term "Paget's disease of the nipple" now generally used to describe the condition was given by Erichsen in 1879.

Cases Recorded.—Jacobaeus (1904) found 70 or 80 cases of this disease reported in the literature; Hannemüller and Landois (1908) collected about 100 case reports; Rosenberg (1909) nearly 120; Reuter (1912) about 130. In my study of the literature, I found more than 200 case reports, 196 of which I read in the original reports or abstracts.

Symptomatology.—The earliest symptom appears usually on the surface of the nipple, rarely on the areola or skin, as a pimple, a pustule, a crack, a red patch, a scab, a horny crust, or an excoriation. Paget distinguished two general types: one, weeping eczematous, the other, dry psoriatic. These may be mixed, or one type may change into the other during the morbid process. Gradually such skin changes spread over the entire nipple and extend over the areola. Rarely do they spread beyond the region of the latter, though in Von Winiwarter's case the condition affected not only the breast but the right thorax and the axilla up to the arm. Vignolo-Lutati, Elliot, Sherwell, and others, reported cases in which the patch extended far beyond the areola. In many cases subjective symptoms are absent. At times in the beginning there is itching; as a rule, this disappears subsequently, though it may be continuous. Often a burning and tingling sensation is complained of; rarely is there shooting or darting pain. When the affection is fully developed, the skin is a very bright red, its surface looking as if lacquered, smooth, eroded, in places superficially ulcerated, and showing sometimes fine granulations. White epithelial islets are often disseminated on the surface. In other places, excoriation or scab formation prevails. The ground of these patches in many cases is not infiltrated. Sometimes, however, peculiar superficial parchment may be palpated ("*Induration papyracé ou en carte de visite*"—Darier). The borders are always well defined and polycyclic, sometimes distinctly indurated. According to some authors, this is the only diagnostic sign by which it may be differentiated from ordinary eczema. Often a little clear viscid fluid is dis-

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charged from the ulcerated surface, or a bloody secretion from the nipple is noticed early in the disease. Many authors since Brocq have concluded that Paget's disease attacks the right nipple more often than the left. In my search of the records, however, I found the contrary to be true. Among 114 cases in which the side affected was stated, the left breast was involved in 60 cases, and the right in 48. In 6 cases the disease occurred on both sides (Lewis, 2 cases, and Tschlenoff, Abrahams, Rosenberg, Jones, each 1 case). The length of stated time that elapsed before the tumor was seen clinically is variable. The shortest time recorded was several weeks (Butlin) and several months (Bowlby); the longest, 20 years (Jamieson), 23 years (Savatard), 25 years (Sekiguchi), 30 years (Fabry and Trautmann). The average interval is one, two, or three years. On the other hand, there are many cases in which no definite tumor mass can be detected clinically even after a long period of time, although sections reveal cancer in the tissue distinctly. In only a few cases was a hereditary tendency towards cancerous disease reported. Of 159 patients, 49 had nursed children. A previous inflammatory process in the breast was recorded by Bowlby, O'Neill, Oldekop, Schulten, Tschlenoff, Andry, Elder, Rolleston and Jopson and Speese. Hanser's case was suddenly exacerbated by erysipelas after the advent of the disease. Trauma seems to have little relation as an etiologic factor in this affection. In Kyrle's case the patient reported that she had had a blow and bruise one and a half years previously. In Murphy's and Sekiguchi's cases injury had occurred 2 years before the appearance of the first sign on the skin, and in Jacobæus's case 7 years before. Hartzell reported a case of a pigmented mole on the forearm which, after being bruised a number of times and undergoing inflammation, caused the association of a nævocarcinoma with the condition of Paget's disease. Cases of this affection on the male breast were reported by Forrest, Jones and Elbogen. I have examined one in addition, making a total of 4 cases.

Extramammary Paget's Disease.—The following regions have been reported as areas in which affections resembling mammary Paget's disease occur: (1) External reproductive organs of male: (a) Scrotum and penis, 4 cases (Crocker, 2 cases; Darier and Couillaud; Rolleston and Hunt); (b) glans penis, 5 cases (Pick, Tommasoli, Tarnowsky, Sequeira, Davis); (c) præputium and frænulum, 1 case (Pospeloff). (2) External reproductive organs of female; vulva, vagina and perineum, 4 cases (Dubreuilh, Rosenberg, Grintschar, Kren). (3) Axilla, 3 cases (Zieler, Holzknecht, Jungmann and Pollitzer). (4) Umbilicus, 2 cases (Fox and MacLeod, Milligan). (5) Nose, 2 cases (Ravogli,

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Matzenauer). (6) Buttocks, 2 cases (Fordyce). (7) Neck, 1 case (Morris). (8) Lower lip, 1 case (Winfield). (9) Abdominal wall, 1 case (Sheild). (10) Forearm, 1 case (Hartzell). (11) Back, 3 cases (Towle, Belot, Omsby).

There has been a total of 30 cases recorded as extramammary Paget's disease. To these I shall add 1 case in which the scrotum was affected.

Many different opinions have been published in regard to the nature of Paget's disease. Briefly, they may be summarized as follows: (1) Ordinary eczema; (2) irritation by a benign tumor of the breast; (3) epithelial dystrophia by neuritis and perineuritis; (4) a peculiar disease, *sui generis* precancerous: (a) psorospermosis, (b) blastomycosis, (c) degenerative epithelial dermatosis; (5) melanoblastoma; (6) naevocarcinoma; (7) primary superficial epithelioma; (8) primary glandular-cell carcinoma from the superficial milk ducts.

REPORT OF CASES PERSONALLY OBSERVED

CASE I (Kondoh's Clinic).—Mrs. K., aged sixty-one years. No history of cancer in family. Married at nineteen; husband healthy. Has given birth to, and nursed, ten children. Has had no inflammation in the breast.

Clinical History.—Six years ago, while she was working in a chemical factory, she noticed a burning sensation on the left nipple. As she had dropped hydrochloric acid on her waist several days before, she concluded that the burn had been caused by the acid. At that time there was a small spot on the nipple, the size of a grain of rice. The area was whitish and excoriated. The eczema spread gradually over the areola. Three months later the nipple flattened and almost disappeared. There was no itching or pain, only a sensation of burning.

Clinical Examination.—Left nipple was flattened. The surface was ulcerated and exuded a viscid fluid. The eczematous area, 9 by 6.8 cm., on the breast was bright red in color and eroded. Part of it was finely granular and a part glistening. Whitish epithelial islets were also to be seen. The margins of the patch were sharply defined, polycyclic and not elevated. There was neither induration nor a nodule in the subcutaneous and deep layer. No glandular enlargement in the axilla.

Operation.—On September 21, 1910, the breast was amputated and the axillary glands cleared out.

Pathologic Findings.—The granulation tissue in the site of the nipple contained enormous plasma cells and newly-formed blood-vessels. There was found also a long column of large proliferated epithelial cells running vertically into the deep layer, which was varied and irregular in shape. Some of the cells were very deeply stained. I believe that this column was a degenerated cancerous lacteal duct. In the remaining

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epidermal layer surrounding the ulcer was a number of big clear cells. These cells were scattered in the epidermal layer of the eczematous part, but were most numerous at the edge of the ulcer near the long cancerous column. In the deep layer were variously shaped rows of cancer cells of the glandular type surrounded by moderately increased stroma, and signifying carcinoma simplex. The cancerous column of the lacteal duct extended into the corium. It was not connected with the cancer rows in the mammary glands, but was separated from them by increased elastic and connective tissue. The separation of both parts might be considered secondary, the result of the reactive process in the corium. There was no glandular involvement in the axilla.

CASE II (Kondoh's Clinic).—Mrs. I., aged forty. No cancerous tendency in family. Married at seventeen; never pregnant.

Clinical History.—About ten months before she accidentally scratched the right nipple with her finger-nail. Since that time the skin had been excoriated and a scab had formed and fallen off again. At the end of five months, she noticed that the mammary gland of that side was somewhat enlarged. One month later a fluctuating area appeared near the nipple, which spontaneously ruptured and produced an ulcer exuding bloody serous fluid. She complained of some pain.

Clinical Examination.—The right breast was much enlarged. Dilatation of subcutaneous veins was visible ("Caput medusæ"). The nipple had ulcerated and disappeared. The areola surrounding the ulcer was eroded and exuded serum. Under the nipple on the outer side was another ulcer. In its centre was the opening of an exuding fistula. In the deep layer could be felt a large, hard tumor the size of the fist. The tumor was attached to the base of the ulcer and the pectoral muscle. Several hard nodules were felt in each axilla.

Operation.—On February 19, 1913, the breast was amputated, the pectoral muscle removed, and the axillary glands dissected out.

Pathologic Findings.—The nipple had been replaced by granulation tissue in which plasma, round, eosinophile and mast cells were greatly in evidence. The elastic tissue had almost disappeared, but in the borders of the ulcer it remained slightly condensed. Just below the granulating surface a large cancerous mass was to be seen. The tumor in this case was almost surrounded by dense connective tissue, but toward the deep layer were scattered small raw formations. The shape of the cancer rows in the main portion was peculiar; many of them were connected with each other, the stroma mingling in an irregular vine-like form. Cheatele distinguished two types of duct cancer—the intracystic papillomatous and the intracystic lactiform. This case should be classified with the latter. The epidermis of the eczematous areola showed in places abrasion of the cornifying and granular layers, and here and there a mass of degenerating epithelium with feebly stained nuclei was present; no typical "grosse und helle Zellen" were found. Therefore, it might be concluded that in this case

the eczematous condition signified a nutritive disturbance due to the compression of the larger cancer mass in the corium, and that it was not caused by an invasion of cancerous cells into the epidermis. However, the clinical history proves that this case cannot be excluded from cases of Paget's disease and considered merely pseudo-Paget's disease, for in the beginning there was no clinical sign of cancer in the deep layer. I believe that the classification of genuine and pseudo-Paget's disease is not rational, for clinically the genuine form, as in this case, should be regarded as primary carcinoma which was latent in the milk duct.

CASE III (Kondoh's Clinic).—Mrs. O., aged sixty-four years. Family history negative. Married at twenty-five; had borne and nursed five children. No trauma or inflammation of breast.

Clinical History.—About one and a half years ago the patient noticed a red spot the size of a pinhead on the tip of the nipple. Four months later it eroded and there was a little exudate. At the same time a small hard nodule appeared in the nipple, which gradually retracted and disappeared. The eczema spread continuously on to the areola.

Clinical Examination.—On the site of the left nipple was a crater-shaped ulcer, 0.5 cm. in diameter and 0.5 cm. deep, which exuded a slightly serous bloody fluid. The surrounding areola was bright red, eroded and sensitive, and its outer zone was of a dark color. The margins of the diseased skin were sharply defined, but not raised (Fig. 1). In the centre of the deep layer was a large hard tumor-mass the size of a child's head, which was attached to the ulcer in the nipple, but movable against the pectoral muscles. In the left axillary and supraclavicular regions, many hard glandular enlargements were palpable.

Operation.—April 6, 1914, the breast was removed.

Pathologic Findings.—In the malpighian and basal-cell layers many single Paget cells were found; they were also in rows which compressed the surrounding epidermal cells. In some places the basal-cell layer had been flattened by compression of the Paget cells. The latter, however, showed no tendency to invade the corium. While there was no distinct transitional form from the surrounding epidermal cells, there was a direct connection between these cells and the glandular cancer-cells on the edge of the ulcer in the site of the nipple. In this area the granulation tissue was mixed with numerous cancer rows which had a direct relation to the tumor-mass in the deep layer. Just below the surface of the ulcer was found a large column of cancer-cells, running downward. This may be considered the residuum of the lacteal duct. The connective tissue in the corium in places had undergone a hyaline change. The increased elastic tissue in the periphery of the cancerous mass showed peculiar granular degeneration. In some of the veins were thrombi of cancer cells and in others calcareous deposits were present. The sweat glands under the diseased skin had become atrophic and their surrounding stroma showed myxomatous degeneration. Hair follicles and Montgomery's glands in

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some places showed proliferation of cells which were intermingled with Paget cells. The lymph-glands along the pectoral muscle contained scirrhus carcinoma (Fig. 1).

CASE IV (Kondoh's Clinic).—Mrs. S., aged fifty years. Family history negative as regards cancer. Patient had given birth to and nursed six children.

Clinical History.—Six years ago she noticed a pimple on the tip of the nipple, which had broken and formed a scab. Shortly afterward another pimple appeared very near the first one; this also broke and changed into an erosion. The area was slightly sensitive to the touch. One year ago the erosion spread over the entire left nipple.

Clinical Examination.—The left nipple was slightly flattened; its surface eroded and showing a few whitish spots. The surrounding areola was bright red (diameter 5 cm.), partly eroded, and exuding clear serum. The borders of the patch were distinctly defined and slightly raised. There was neither induration nor nodules in the superficial or deep layers.

Operation.—On November 11, 1914, the breast was amputated.

Pathologic Findings.—The cornified stratum of the diseased nipple had disappeared almost entirely; in places all of the epidermal layers were eroded and replaced by small ulcers. In the epidermis near the outlet of a milk duct, a number of Paget cells were found, especially in the malpighian and basal-cell layers. These cells were scattered also in other parts of the eczematous skin, but their number was relatively small in comparison with those in the vicinity of the milk duct. In the corium of the nipple a long column of glandular cells extending down to the deep layer was evidently a cancer-changed lacteal duct, and in serial sections it was found to be directly connected with the smaller milk ducts. The cancerous degeneration of the wall of the milk ducts was apparently gradual. The most manifest development of carcinoma took place in the superficial lacteal duct and invaded the branches in the deeper layer along its course. In some of the small milk ducts, one side of the wall had not lost its normal columnar epithelial lining, although the other side had changed into cancer and invaded the surrounding stroma (Fig. 17). Around these milk ducts elastic tissue was very much increased. In connection with this case emphasis should be laid upon the fact that only one lacteal duct in the nipple had changed into cancer, and that others found in the sections showed dilatation of the lumina, but no cancer. In the subpapillary corium the infiltration of plasma cells, eosinophile cells, mast cells and small lymphocytes was striking. The first formed an annular infiltration around cancer rows from the milk ducts. The increase of the elastic tissue in the corium of the nipple was remarkable, most of its fibres running vertically (Fig. 19). The same tissue increased also surrounding the cancerous degenerating milk ducts in the deeper layer (Fig. 18).

CASE V (Kondoh's Clinic).—Mrs. I., aged fifty-five years. Family history in regard to cancer negative. Patient had never been pregnant. Ten years ago she suffered from myoma of the

uterus which was treated with injections of ergotin, resulting in much improvement. No clinical symptoms since. Twelve years ago a tumor about the size of a nut appeared in the right breast. It was removed and proved to be benign.

Clinical History.—Twenty-five years ago the patient discovered a slight scab formation on the tip of the left nipple which itched slightly. It was followed soon after by erosion with exudation of serous fluid. Two years later the entire left nipple was eroded. Eight years after the beginning of the disease the eczematous condition spread over the whole areola. Itching and dull pain were complained of (Fig. 3). In July, 1913, the patient was treated by Röntgen rays once a week. After six treatments an acute dermatitis of moderate intensity developed (Fig. 4). This was healed in the course of two weeks by the application of tumenol—Wilson paste. With the disappearance of the dermatitis, the morbid condition of the skin was entirely cured with epidermatization. Depigmentation, however, still indicated the old diseased area (Fig. 5). The surrounding normal skin was overpigmented. The nipple was flattened up to the trace. Half a year later the eczematous change of the skin again developed in the upper inner quadrant of the breast, some distance from the nipple. The latter was pinkish in color and injected. A hard tumor mass was palpated in the mammary gland just beneath the nipple. The lymph-glands in the axilla were not enlarged.

Operation.—On November 21, 1914, the breast was amputated.

Pathologic Findings.—The thickness of the epidermal layer of the nipple and areola was reduced, but unimpaired. The epidermis appeared dense; in other words, the intracellular spaces of the malpighian layer were decreased, and as a result the cells were closer together. There were no epithelial alterations and no Paget cells excepting in a small area of the areola. In the corium was a dense connective-tissue-like scar. Plasma cells and elastic tissue, which were characteristic features in the other cases, were scarce. I believe that this was due to the use of the Röntgen ray, which probably suspends cell-infiltration and elastic-tissue hyperplasia in the corium. The fact that some sweat glands were evidently atrophic and their periglandular stroma had undergone hyaline degeneration, must be ascribed to the same cause. Beneath the nipple, intercepted by the above-mentioned dense connective tissue, was a large cancerous mass which consisted of small glandular cells and very little stroma. On the inside it showed a typical alveolar formation. In the centre of the large focus some coagulation necrosis had occurred. The appearance of the small area on the areola, where the eczematous condition had recurred, was peculiar. The stratum corneum and granulosum had been destroyed, the malpighian layer was sprinkled with Paget cells, and the surrounding cells had undergone necrosis. The basal-cell layer in this area showed slight proliferation. The origin of the cancer in this case is hard to decide. There was no residuum of the lacteal ducts. The clinical course and the fact that the diseased skin was promptly cured by Röntgen rays and that

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after its disappearance the tumor mass was detected beneath the nipple, suggests that the origin of the tumor was under the epidermis and that it could invade the deep layer more easily than before because the protective reaction of the corium had been destroyed by the Röntgen treatment.

CASE VI (Kondoh's Clinic).—Mr. S., aged sixty-five years. Family history negative. Denied venereal diseases. Married at twenty-four. Wife in good health. Six children.

Clinical History.—For nine years the patient had had an eczematous condition on the scrotum that was accompanied by severe itching. The diseased area was excoriated and partly eroded. Two years ago he noticed a scab formation on the right scrotum the size of a cent. This he scratched off. The condition at times was stationary, but gradually became worse. Two months previously the centre of the patch was ulcerated and discharged a little serous, foul-smelling fluid.

Clinical Examination.—The scrotum was swollen. The left side was excoriated and reddened as though affected with chronic eczema. On the right side, some distance from the radix penis, was a crater-shaped ulcer the size of a half-dollar. Its borders were irregular, raised, elastic and hard. The surrounding skin was bright red, not indurated, but partly excoriated and partly eroded. One part of the foreskin which came into contact with the ulcer of the scrotum showed two small eroded areas, a little infiltrated (Fig. 6). The testicles and epididymis were free from pathologic changes. The femoral and inguinal glands on both sides were enlarged and hardened. The right leg in general was oedematous.

Operation.—The penis and scrotum were excised and the lymph-glands were cleaned out July 1, 1914.

Pathologic Findings.—In the granulation of the ulcerated part there were many cancer rows, lined by cuboid or columnar cells which surrounded a lumen. The cells stained by Opplar's method showed no eleidin particles. The tumor must be classified as an adenocarcinoma (Fig. 23). The cancerous rows extended into the deep subcutaneous tissues, but were not connected with the testicles. The epidermal layer at the border of the cancerous ulcer showed a proliferation of cells; its border next to the corium had become very irregular (Fig. 22). In this part of the epidermis many Paget cells were found in direct transition from glandular cancer cells. The eczematous area, located some distance from the ulcer, also showed a remarkable proliferation of the epidermal cells. As the greater number of Paget cells were found between the non-proliferating superficial and the proliferating deep epidermal layers, the proliferation of the epidermal cells must be regarded as a reaction caused by the Paget cells similar to that resulting from foreign bodies. No distinct increase of the elastic tissue in the stroma and not much infiltration by the plasma cells were noted. The eroded part of the foreskin was deprived of the cornified layer and showed Pagot cells mingled in the thickened mucous layer. This finding seemed to signify that Paget cells may be inoculated into an epidermal

layer that has been in contact with the original cancer focus. The inguinal glands showed metastases of the type of glandular carcinoma. In this case it was very hard to determine the origin of the cancer. The fact that the carcinoma cells were of glandular-cell type, and that large, long, columnar-shaped groups of cancer cells in the superficial corium ran almost perpendicularly to the ulcerated surface, might suggest that the sweat glands or their ducts were the origin of the neoplasm.

CASE VII (G7776, Mayo Clinic).—Miss M. M., aged thirty-two years. Family history negative.

Clinical History.—One and a half years ago the left nipple became irritated and then excoriated. Applications of vaseline were of benefit. One year ago the patient noticed a nodule in the breast. No pain was complained of.

Clinical Examination.—The nipple was flattened and ulcerated; the granulations were bright red and there was a slight discharge. The areola directly surrounding the ulcer was in an eczematous condition. The borders of the diseased skin were well defined but not raised. Several hard nodules were palpated in upper outer quadrant. No enlargement of axillary glands.

Operation.—Halsted's amputation performed Aug. 14, 1906.

Pathologic Findings.—No cancer rows were found in the granulation on the nipple. In the epidermis on the edge of the ulcer, however, were groups of Paget cells which were scattered in the mucous and basal layers of the skin. In the deeper layer beneath the ulcerated surface I found several large irregular ovoid cancer rows, which consisted of glandular cells mingled with large clear cells resembling the Paget cells in the superficial layer. These cancer rows probably originated in a lacteal duct. The Paget cells in the epidermal layer formerly may have had some connection with them which was broken by the reactive hyperplasia of the stroma. The large cancer rows were directly related to the tumor mass in the upper, outer quadrant of the breast, the two foci being connected by numerous small cancer rows. The character of the tumor mass was that of typical carcinoma.

CASE VIII (A15,629, Mayo Clinic).—Mrs. S., aged fifty-eight years. Family history negative. Patient had had four children.

Clinical History.—Three years previously the left nipple became cracked and eroded and was cauterized by a physician. This left a hard spot just below the nipple. A year before, the nipple was injured by the corset and again healed slowly. It became more tender and red than before, but the eczematous spot seemed little changed.

Clinical Examination.—The left nipple was flattened, ulcerated and bright red, and discharged a little clear fluid. The base of the ulcer was hardened; the areola eroded and sharply defined. In the middle of the breast was a hard nodule, the size of a pigeon's egg, which palpation showed had no direct connection with the diseased skin.

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Operation.—October 7, 1908, a Halsted amputation with Jackson's incision was done.

Pathologic Findings.—The nipple had been replaced by a cancerous infiltration continuous with the deep layer of the mammary gland. In places, especially on its peripheral portion, the tumor was a distinct papillary carcinoma. On the edge of the ulcer the cancer rows came directly in contact with the epidermal layer. In those parts the transformation of the glandular cancer cells into Paget cells was out of the question (Fig. 12). The skin of the eczematous part of the areola had lost its cornified stratum and the mucous layer, which contained Paget cells, was exposed. The greater the distance from the edge of the ulcer, the smaller was the number of Paget cells. In this case the situation of the lacteal ducts was not distinguishable as the entire nipple had been destroyed and replaced by cancerous infiltration. However, the papillary nature of the tumor might suggest that it had its origin in the milk ducts.

CASE IX (A23,915, Mayo Clinic).—Mrs. S., aged sixty years. Family history negative.

Clinical History.—About a year previously, the patient noticed a burning sensation in the left breast and a discharge from the nipple. At about the same time the centre of the nipple became ulcerated. This was improved temporarily by the Röntgen ray. The ulcer had been increasing in size during the last three or four weeks. The eczematous area, including the ulcer, was $\frac{1}{4}$ inch in diameter.

Operation.—The breast was amputated June 2, 1909.

Pathologic Findings.—The epidermal layer of the nipple was entirely destroyed and its site was filled by granulation tissue containing a large number of plasma cells and a similar number of eosinophiles and small lymphocytes. A large column of cancerous cells extended almost perpendicularly into the deep layer and was connected with several deep, smaller cancer rows. The carcinoma was of the glandular-cell type. The elastic tissue was greatly increased around the large column and less increased around the small cancer rows in the deep layer. The greater part of the mammary gland, except the above-mentioned degenerated cancerous area, was atrophied. In some areas, however, there was a chronic cystic condition. The eczematous portion of the skin contained a small number of Paget cells scattered in the malpighian layer.

CASE X (A34,572, Mayo Clinic).—Mrs. A., aged forty-eight years. Patient's maternal aunt had had carcinoma of the breast. The patient had borne and nursed four children.

Clinical History.—While nursing she had had some pain in the left breast. A year ago a spot appeared on the clothing over the left nipple. For several weeks the nipple had been sore and a raw spot had been cauterized by a physician. Resulting scab came off. After cauterization patient noticed lump in breast.

Clinical Examination.—The left nipple was covered by a scab formation the removal of which exposed an eroded surface. No induration on the ground of the patch could be felt. The glandular portion of the left breast was in general firmer than that of the right, but not so hard as in cancer. No glandular enlargement of the axilla was detected.

Operation.—Halsted amputation performed Feb. 28, 1910.

Pathologic Findings.—The epidermis of the nipple in places had lost the stratum corneum and granulosum, but not all of its layers. In a study of a number of serial sections, I was able to find a lactiferous duct which was cancerous in its most superficial part. Fig. 14 shows that the lactiferous duct increased in size and in the direction of the subcutaneous layer assumed a club-like shape. Near its orifice the border line of the stroma remained more or less intact (except toward the deeper layer) and the elastic tissue was to some extent increased, as indicated by Weigert's stain. In the part nearest the duct the elastic fibres ran parallel to the borderline of the lactiferous duct; at the side they formed an irregular network. The majority of the fibres were rather slender and many of them terminated in sharp points. There was no thick lump of elastic tissue and no granular degeneration. In short, the hyperplasia of elastic fibres was in an early stage. The epidermal layer at the orifice of this lactiferous duct indicated some disturbance of its cell arrangement, and contained a small number of Paget cells. Paget cells were limited in this vicinity, and were directly related to the carcinomatous degenerating epithelial cells of the lacteal duct. There was no transitional form between them and the surrounding epidermal cells. The cancerous degeneration of the lining cells of the lactiferous duct was visible a little deeper and formed several small cancerous rows. The lumina of the smaller milk ducts in the deep layer were dilated here and there, but did not show cancerous degeneration. Sections of the glandular portion of the breast revealed chronic cystic mastitis, but no area of cancer. The restriction of the cancer rows to one lactiferous duct and the limited number of cancer rows proved the condition to be in the earliest stage of carcinoma from the superficial lactiferous duct (Fig. 14).

The most important fact in this case was that only a single lactiferous duct showed cancerous degeneration of its lining cells. This I ascertained by an examination of more than five hundred sections. Other lactiferous ducts showed no pathologic changes. At the most, there was only some dilatation of their lumina and desquamation of the lining cells. It may be stated here that chronic cystic mastitis is a condition that is commonly associated with cancer of the breast. Undoubtedly the chronic irritation of cancer is the cause of this condition in the surrounding glandular tissue.

CASE XI (A42,024, Mayo Clinic).—Mrs. B., aged thirty-six years. Family history negative.

Clinical History.—For seven months the patient had had a sore on the left nipple which did not heal. At about the same time an erosion appeared there and gradually enlarged. After a

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while a thickening beneath the nipple was noticed. No subjective symptoms were complained of.

Clinical Examination.—The left nipple was bright red and a little retracted. Its centre was slightly eroded. A hard nodular mass was palpated directly beneath the nipple. Several of the lymph-glands in the left axilla were enlarged.

Operation.—A Halsted amputation was done August 30, 1910.

Pathologic Findings.—The epidermis still remained intact in spots and contained Paget cells in varying numbers. The deeper part of the nipple was almost entirely filled by numerous cancer rows, which did not show any cornification or epidermal pearls. These were connected directly with the cancerous mass in the glandular part. The latter was a scirrhous carcinoma. A direct transformation of cancer cells into Paget cells in the epidermis was noted in several areas where the cancer rows came in touch with the skin layer (Fig. 13). In the enlarged axillary lymph-glands were metastases of scirrhous carcinoma.

CASE XII (A53,174, Mayo Clinic).—Mrs. H., aged fifty-nine years. Family history negative for cancer. Patient had borne and nursed two children.

Clinical History.—Three years ago the patient first noticed a scab on the right nipple. This was removed occasionally in bathing. There was no secretion except when the scab was removed. One portion of the nipple was ulcerated and the nipple gradually flattened. Patient had noticed thickening in breast.

Clinical Examination.—The right nipple was flattened and showed a scab formation. In some parts there was bright red granulation tissue. The surrounding areola appeared to be affected with an eczematous condition with well-defined borders. A vague thickening was detected on palpation directly under the nipple.

Operation.—Halsted amputation performed June 13, 1911.

Pathologic Findings.—The skin layer surrounding the ulcer contained a large number of Paget cells, some of which were extraordinarily large and in places formed distinct rows between normal squamous cells (Fig. 9). The latter were strongly compressed by the former and were so slender that they had the appearance of the stroma of connective tissue. In the granulation tissue of the nipple a large, long cancer-cell aggregation extended down vertically into the deep layer, where it connected with many branching and degenerated cancerous milk ducts. This relationship could be confirmed only by examining several hundreds of serial sections. In places the mammary gland had undergone atrophy. An extensive plasma-cell infiltration in the subcutaneous tissue and a noticeable increase of the elastic tissue surrounding the degenerated blastomous milk ducts had the same characteristics in this case as in many others.

CASE XIII (A76,230, Mayo Clinic).—Mrs. A., aged fifty-seven years. An aunt had died of cancer.

Clinical History.—About three years previously the patient began to have a slight watery discharge from the left nipple. This was followed by an eczematous condition of the surface. During the preceding six months there had been an occasional slight bloody discharge. No tumor had been detected in the breast. The nipple had not become retracted until six months before. At that time the patient noticed some glandular enlargement in the left axilla. During the preceding spring she had had Röntgen treatment for a month. No pain.

Clinical Examination.—The surface of the left nipple was almost entirely eroded, but no open ulcer was visible microscopically. The eczematous condition had spread over the areola in a narrow zone surrounding the nipple. In the glandular part no nodule or thickening could be palpated. The axillary glands were enlarged and hardened.

Operation.—The breast was amputated November 26, 1912.

Pathologic Findings.—The epidermal layer had disappeared from the greater portion of the nipple and cancer rows were exposed on the surface. The tissue of the nipple itself had been almost entirely replaced by a carcinomatous mass which was connected with a deeper cancer mass by means of many small rows of cells. The rows of cancer cells in the glandular part were enclosed by increased elastic tissue and also by an annular plasma-cell infiltration. In the basal-cell layer and the subpapillary tissue of the eczematous areola, numerous pigment cells were mingled with large lumps of pigment. Some of the Paget cells contained pigment particles in their cell-bodies, perhaps as a result of their phagocytic action. The substitution of unstriated muscle fibres for elastic tissue was unquestionably demonstrated in this case, especially in the surrounding stroma of the cancerous mass of the nipple (Fig. 20.)

CASE XIV (A104,355, Mayo Clinic).—Miss T., aged forty-one years. Family history negative.

Clinical History.—A year previously the patient noticed a red spot on the tip of the right nipple. Soon afterward a small nodule developed in the area close to the reddened skin. Several months before a hard spot was detected in the centre of the glandular part.

Clinical Examination.—The right nipple was entirely ulcerated. The surrounding areola was eroded in a narrow zone. The nipple itself had been changed into a hard, red tumor-mass, the size of a small nut. In middle of mammary gland some distance from tumor of nipple was another small hard nodule.

Operation.—On April 16, 1914, the breast was amputated.

Pathologic Findings.—The cornified and granular layers of the epidermis of the nipple had been destroyed. Paget cells were noticed only in the vicinity of the outlet of a lacteal duct. The latter, remarkably enlarged, extended vertically into the deep layer. Its lining cells were in

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complete disorder and their nuclei were irregular in shape; in short, malignant degeneration of the cells was evident. A little deeper beneath the nipple a mass of cancer-cell rows of glandular-cell type was found. The main part of the mammary gland had undergone chronic cystic inflammation. Paget cells were discovered on the edge of the ulcer, which extended nearly to the mouth of a lactiferous duct. This case, like that reported by Thin, affords in its clinical history a suggestion of primary duct-cancer, and in the pathologic findings presents the picture of Paget's disease. There is no longer any doubt that, although in this disease a primary duct-cancer may be limited in its origin to a certain particular part of a duct, it may give rise to the same clinical and pathological conditions as Paget's disease (Fig. 16).

CASE XV (A117,817, Mayo Clinic).—Mr. J. P., aged sixty-seven years. Two years previously the patient injured himself over the right breast on a wagon box. The wound healed in several weeks. Later the skin of the right nipple began to itch. Scratching caused the formation of an ulcer. Perspiration and irritation made it larger. The preceding winter, when he was idle, wound nearly healed, but since then it had been gradually increasing in size. A slight discharge from the ulcer was noticed.

Clinical Examination.—The ulcer on the right nipple was bright red, hard and indurated. Its borders were sharply defined, but not elevated. Directly beneath the ulcer and attached to it was a tumor-mass the size of a hen's egg. No other nodule or thickening was to be discovered in the glandular part. The axillary glands were not enlarged.

Operation.—Halsted's amputation performed Nov. 12, 1914.

Pathologic Findings.—The granulation tissue which formed the ulcerated part of the nipple was mingled with numerous small rows of cancer cells, some of which surrounded lumina lined with cylindrical cells. The eroded area of the skin surrounding the ulcer was characterized by decided degeneration of the epidermal cells mingled with Paget cells. The difference between the degenerated epidermal cells and Paget cells was evident in this case, because the cell-bodies of the former were destroyed and had lost the staining qualities of their nuclei. The latter still retained the distinct contour of their cytoplasm and contained one or two densely-stained nuclei, showing in places mitotic figures.

CASE XVI (A128,147, Mayo Clinic).—Miss R., aged thirty-seven years. The patient's mother had had cancer of the breast.

Clinical History.—Five years before, the patient had noticed a slight discharge and a scab formation on the right nipple. When the scab fell off, the nipple showed a superficial erosion, and discharged a little bloody fluid. The scab formed again quickly, but fell off every four or eight weeks. No pain.

Clinical Examination.—A scab covered the tip of the right nipple. When this scab was removed a small granulating ulcerated

surface was exposed. The skin of the nipple was excoriated and tender and on pressure exuded a little bloody pus. No induration was discovered in the mammary gland.

Operation.—On June 4, 1915, the right breast was excised.

Pathologic Findings.—The epidermal layer had disappeared from the greater portion of the nipple and had been replaced by granulation tissue which contained numerous rows of cancer cells. Thick and dense elastic fibres were scattered through the stroma. Some of the rows of cancer cells connected with the basal layer of the skin had encroached upon it, taking the form of Paget cells (Fig. 15). In the subpapillary layer, directly beneath the eroded skin of the areola, were many transverse, ovoid and remarkably dilated blood-vessels. The dilatation was due to compression by the cancerous infiltration just below. It is perhaps because of these dilated blood-vessels under the epidermis that the eroded skin is of such a bright red color in this disease (Fig. 11). The tumor in this case was a glandular-cell carcinoma.

CASE XVII (A134,558, Mayo Clinic).—Mrs. T., aged fifty-two years. Family history negative.

Clinical History.—A few years ago the patient noticed a small bloody stain on the clothing covering her chest. Up to three months before she had noticed this every month. In the previous three months and especially in the last month, a little pus had been discharged from the nipple. No thickening or nodule could be detected at that time. For several months erosion and crack formation had been noticed on the nipple. Six weeks previously a small lump developed in it. Wound slightly sore.

Clinical Examination.—The left nipple was generally injected, in places eroded, and showed several deep cracks. The surrounding areola was excoriated in a narrow zone. The nipple was hardened. No tumor formation was detected in the glandular part. The axillary glands were not enlarged.

Operation.—Halsted's amputation performed June 30, 1915.

Pathologic Findings.—This is the second case in which primary duct-cancer is suggested by the clinical history. However, the subsequent course of the disease and the pathologic findings showed it to be genuine Paget's disease. The results of the histologic examination were almost the same as that of Case XIV. I believe that the appearance of the Paget cells and the consequent alterations of the epidermal layer are parallel to the degree to which the glandular cancer cells have migrated into the epidermal layer. The fact that Malinowsky and others were not able to find Paget cells in their so-called pseudo-Paget's disease, was due simply to a lack of migration of the cancer cells into the epidermis. In other words, if cancer cells from the deep layer had encroached on the epidermal layer, as in my two cases, there would have been no greater difference between the clinical and histologic findings in that case and those of the genuine (precancerous) type of Paget's disease (Fig. 7).



FIG. 1.—Case III. Mrs. O., Kondoh's Clinic. Paget's disease of the nipple.



FIG. 2.—Case IV. Mrs. S., Kondoh's Clinic. Paget's disease of the nipple.



FIG. 3.—Case V. Mrs. I., Kondoh's Clinic. Paget's disease of the nipple. Photograph taken before Röntgen ray treatment.



FIG. 4.—Case V. Mrs. I., Kondoh's Clinic. Paget's disease of the nipple.



FIG. 5.—Case V. Mrs. I., Kondoh's Clinic. Paget's disease of the nipple. Temporarily healed condition of the diseased skin. Depigmentation left after the disappearance of the dermatitis.



FIG. 6.—Case VI. Mr. S., Kondoh's Clinic. Apparent carcinomatous ulcer-formation after long-continued extramammary Paget's disease. Cancerous crater on the right scrotum. Left part shows an eczematous condition. Penis in paraphimosis.

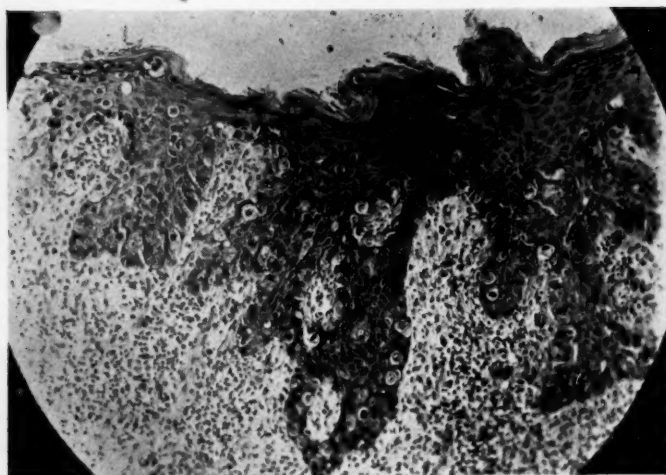


FIG. 7.—Case XVII. Paget cells scattered in the epidermal layer. The latter proliferated.

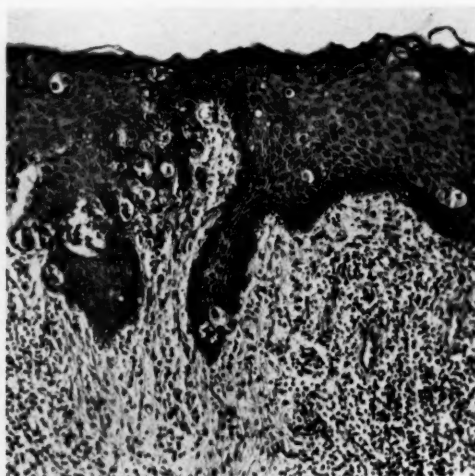


FIG. 8.—Case IX. Paget cells in the epidermal layer. The stratum corneum has fallen off.

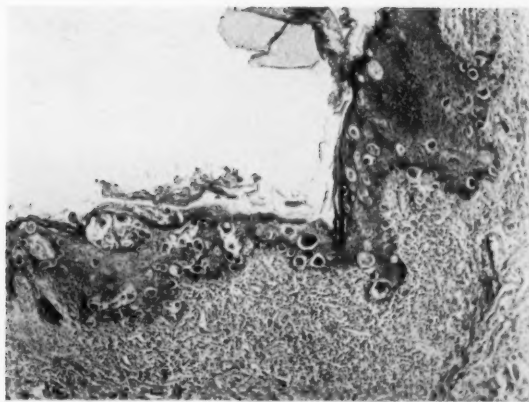


FIG. 9.—Case XII. Eczematous area of the skin, showing many Paget cells in the epidermal layer. These cells caused the proliferation of the epidermal layer (right) and destroyed the latter (left).

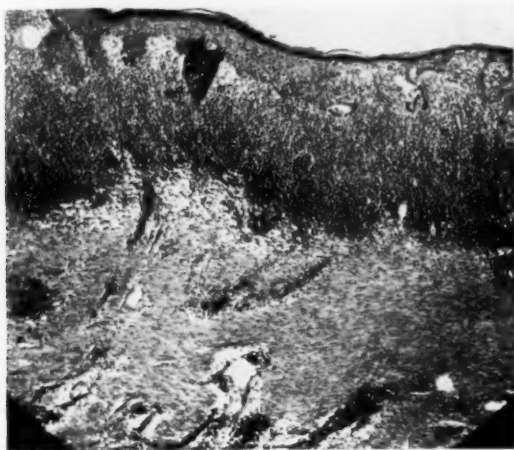


FIG. 10.—Case XVIII. Plasma-cell infiltration in the superficial corium.

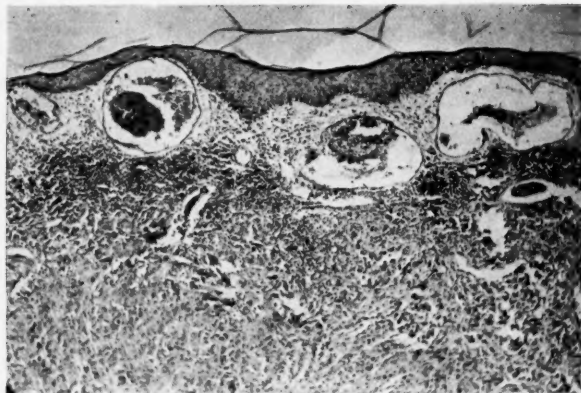


FIG. 11.—Case XVI. Dilated blood-vessels in the subpapillary part of the corium. Cancerous infiltration below.

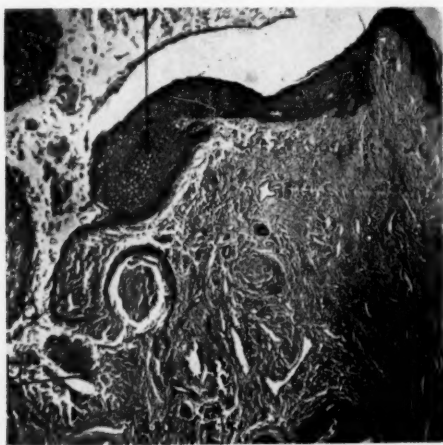


FIG. 12.—Case VIII. Section of the edge of an ulcer of the nipple. *a*, thickened epidermis; *b*, papillary carcinomatous rows.

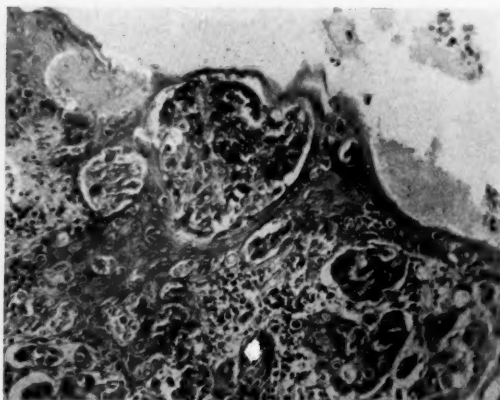


FIG. 13.—Case XI. The cancer rows coming into contact with and entering the epidermal layer and taking the form of Paget cells.



FIG. 14.—Case X. A superficial lactiferous duct showing cancerous degeneration and cancer cells making their way into the epidermis. These glandular cancer cells take the form of Paget cells. *a*, the orifice of the lactiferous duct; *b*, the cancer cells making their way into the epidermis; *c*, the epidermis layer of the nipple; *d*, the cancerous degenerating superficial lactiferous duct; *e*, the desquamated epidermis.

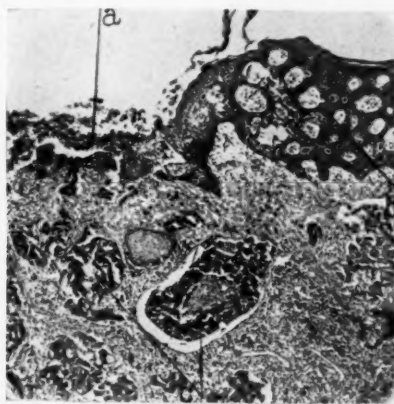


FIG. 15.—Case XVI. The edge of the ulcer of the nipple; *a*, the surface of the ulcer in the site of the nipple; *b*, thickened epidermis containing Paget cells; *c*, cancer rows.

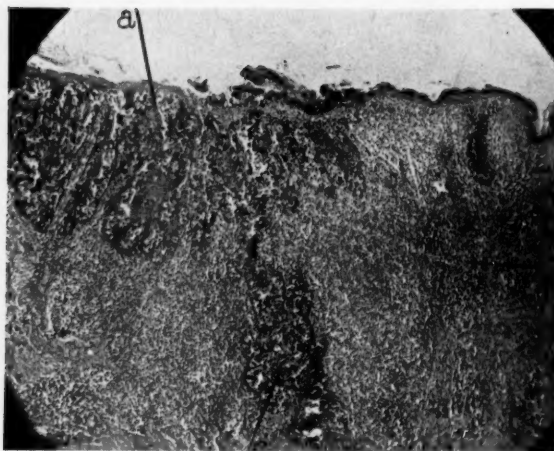


FIG. 16.—Case XIV. The vicinity of the orifice of the cancerous degenerating lactiferous duct. *a*, epidermal layer thickened and invaded by Paget cells; *b*, granulation tissue in the corium, with plasma-cell infiltration; *c*, cancerous degenerating lactiferous duct.



FIG. 17.—Case IV. Milk duct in the deeper layer. One part of its wall (right) retained the normal structure (two-layered columnar cells); the outer part of the wall (left) is changed to a cancer formation. The milk duct below shows a dilated lumen, but no cancerous degeneration of its lining cells.

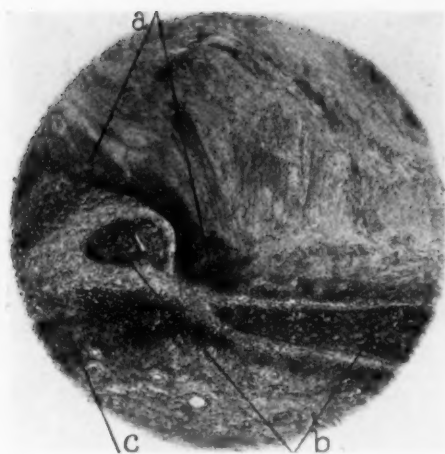


FIG. 18.—Case IV. Cancerous degenerated milk duct surrounded by plasma-cell infiltration and reacted upon by the hyperplasia of the elastic tissue. (Weigert's elastica stain+lithium-carmin). *a*, increased elastic tissue; *b*, cancerous degenerated milk duct encircled by plasma-cell infiltration; *c*, elastic tissue.

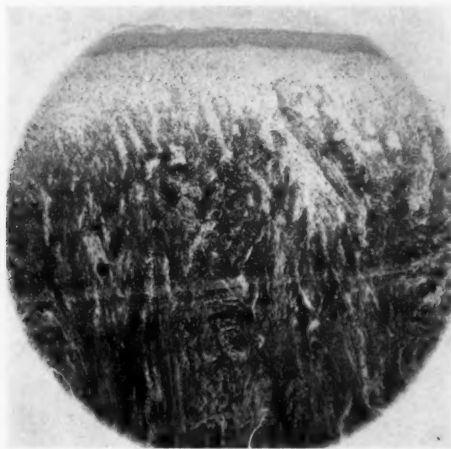


FIG. 19.—Case IV. Exceptional hyperplasia of the elastic tissue in the corium of the nipple. Most of the elastic fibres run vertically.

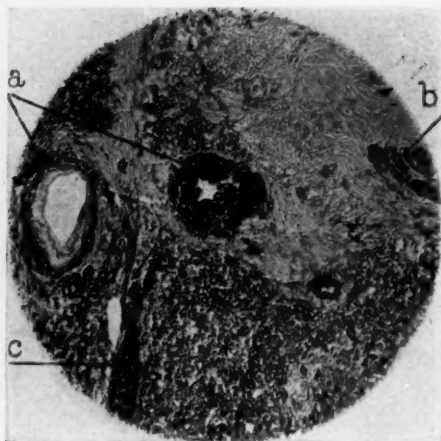


FIG. 20.—Case XIII. Hyperplasia of the elastic tissue in the stroma. *a*, vessel wall; *b*, lump elastic tissue; *c*, muscle fibre superseded by elastic tissue.

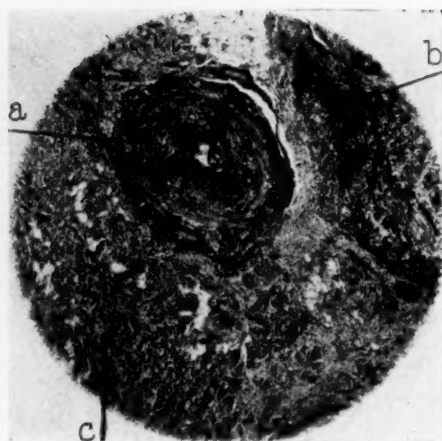


FIG. 21.—Case XI. Hyperplasia of the elastic tissue. *a*, vessel wall; *b*, lump of elastic tissue; *c*, cancer rows.

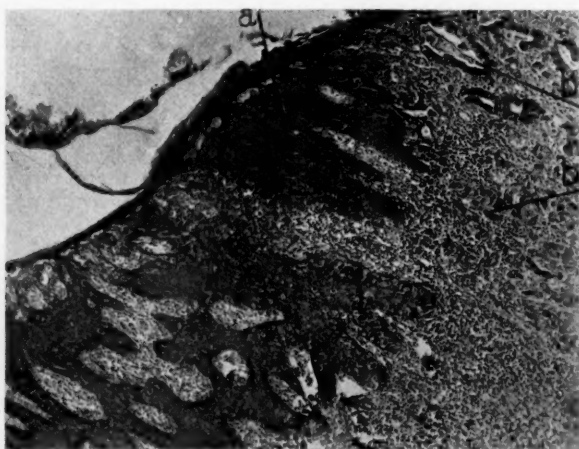


FIG. 22.—Case VI. Section from the edge of the cancerous ulcer on the scrotum. *a*, epidermis proliferation with mingling of Paget cells; *b*, cancer rows connected with the epidermal layer and encroaching upon it. Many Paget cells are to be observed here.

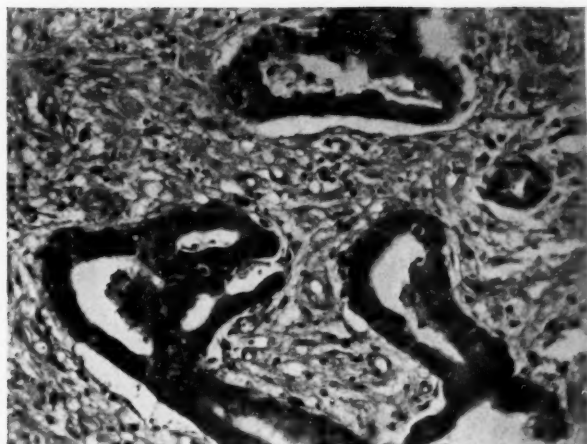


FIG. 23.—Case VI. Same as Fig. 22. Higher magnification of cancer rows (adenocarcinoma).

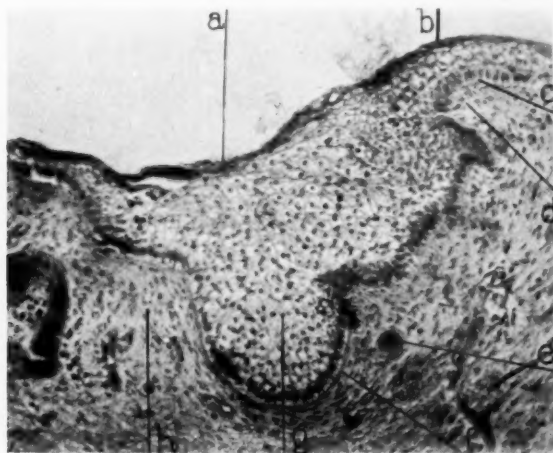
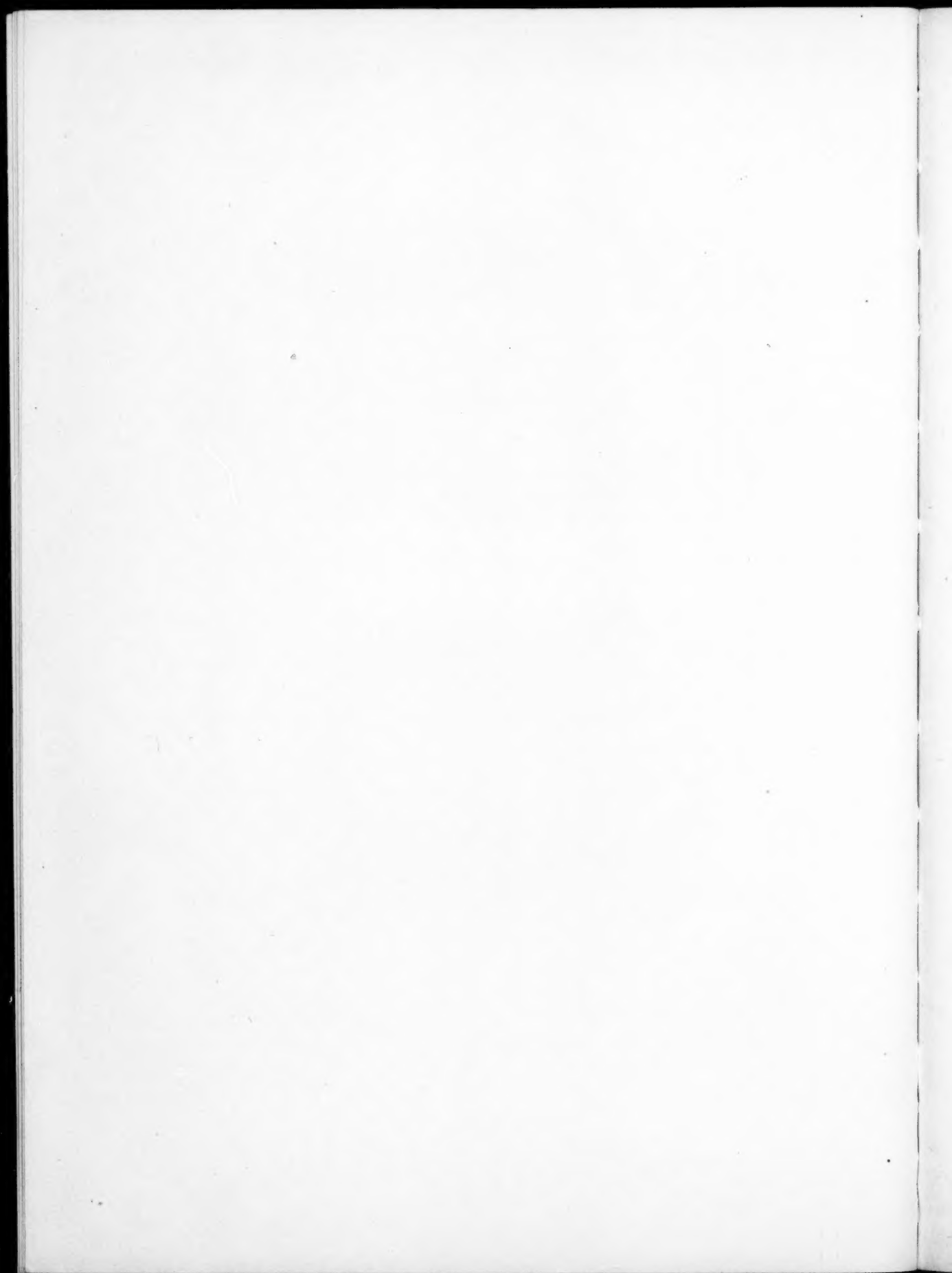


FIG. 24.—Mammary anlage of a human embryo (fifteen weeks). *a*, Gegenbaur's "*Drüsenfeld*"; *b*, epitrichium; *c*, stratum cylindricum; *d*, corium wall; *e*, young vessel; *f*, basement membrane; *g*, mammary bud; *h*, mesoderm.



PAGET'S DISEASE OF THE NIPPLE

CASE XVIII (A136,962, Mayo Clinic).—Mrs. K., aged forty-four years. Family history as regards cancer negative. Patient had given birth to and nursed two children.

Clinical History.—About three years previously, the patient noticed a small abrasion on the left nipple, which enlarged very slowly. One year before she was treated by Röntgen rays and the affected skin seemingly healed up. Several months previously the eczematous condition came on again, and the nipple occasionally became encrusted. At the same time a small indefinite thickening in the glandular part developed.

Clinical Examination.—The left nipple was abraded, its tip ulcerated, bright red, and slightly weeping. Eczematization spread over the surrounding areola. The margins of the patch were sharply defined. The ulcer itself was not indurated, but in the upper inner quadrant was an indefinite thickening in the subcutaneous layer and some atrophy of the cutaneous tissue. No glandular enlargement in the axilla was detected.

Operation.—On July 27, 1915, complete amputation of the left breast was done.

Pathologic Findings.—The granulation tissue in the site of the nipple consisted of fibroblasts, newly-formed small blood-vessels and extensive plasma-cell infiltration, mingled with eosinophile cells and lymphocytes (Fig. 10). In the deeper part were many rows of cancer cells surrounded by elastic tissue and annular plasma-cell infiltration. A large, long column of glandular cancer cells which extended down into the tissue nearly vertically may have been a cancer-degenerated lacteal duct. Paget cells were numerous in the areolar skin. However, in this case no relation between the Paget cells and the rows of cancer cells could be discovered, even in numerous serial sections. Perhaps this condition was secondary, and due to a reactive hyperplasia of the stroma. Such an hypothesis might be justified by comparing these findings with those of other cases just reported. The subcutaneous thickening in the upper inner quadrant was a scirrhous carcinoma which seemingly did not have any direct connection with the cancer rows beneath the nipple. It is probable that it was caused by metastasis through the lymph-spaces. Although atrophy of the skin was noted clinically, the epidermal layer was not in direct contact with the cancer rows, but was separated from them by a narrow zone of dense connective tissue.

SUMMARY OF PATHOLOGIC FINDINGS

From the pathologic findings of these cases, the points necessary to give a general idea of the affection are summarized below:

Epidermis.—In the epidermis I found, in general, two different types of alteration—the one a thickening, the other a thinning or destruction. The thickened part of the epidermis for the most part surrounds the edges of an ulcerated or eroded area and shows proliferation of the cells of the malpighian layer. The thinning is usually at the expense

of a cornified or granular layer. In both places, peculiar large and clear cells, so-called Paget cells, are seen mingled. The number varies in different cases. These cells are always larger than normal epidermal cells, sometimes double or three times their size, distinctly round, or slightly oval. In fixed sections they are doubly contoured, but in fresh frozen sections cytoplasm completely fills the capsule. The cytoplasm is homogeneous, but at times contains variously shaped vacuoles. There may be one or two nuclei. The chromatin stains very densely. Karyokinesis may often be observed. No epithelial fibrillation and no prickle are visible. Eleidin particles are not present. Darier calls these cells "cellules dyskeratosiques." It is a question, however, whether as degenerated epidermal cells they have lost the faculty of keratinization or whether they never had it from the beginning. This will be discussed later on. Cells of this type are most numerous in the malpighian layer of the eczematous area, especially at the edge of the ulcer, somewhat fewer in the basal-cell layer and rare in the superficial cornified stratum. Even in the latter, they do not show any tendency to cornification. I would emphasize the fact that in the early stage of this affection Paget cells are found in the largest numbers in the neighborhood of the outlets of the lacteal ducts (Fig. 16). They are found also to a certain extent deep in the walls of the lacteal ducts which show cancerous metamorphosis of the lining cells. In the advanced stage of the disease, they are scattered widely in the epidermal layer, sometimes forming distinct rows. They flatten the surrounding normal epidermal cells, giving them the appearance of stroma between rows of clear, large cells. Often the basal cells are extremely compressed and become very flat and linear, forming a boundary line between the epidermis and the corium. From their characteristics, I cannot believe with Unna that Paget cells are simply degenerated epidermal cells or epithelial oedema. Active karyokinesis, compression of the surrounding cells, the maintenance of form even in the cornified stratum, in short, such increased vitality, cannot be explained as being the result of regressive metamorphosis of the ordinary epidermal cells. On the other hand, however, they never show any tendency to invade the corium and I have never noted apparent transition from Paget cells into squamous epithelial cancer-cells. This is the difficulty in accepting the opinion of Karg and Krogus, who call these cells "erste Krebszellen," meaning the very first anaplastic epidermal cells degenerating *in loco*. I have no doubt that Paget cells are tumor cells, but I do not believe they originate in the local epidermis. The grouping of these cells in the outlets of lacteal ducts in the early stage of the disease and their vacuolated, seldom fatty, degeneration, lead me to the opinion that they are tumor

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cells which have migrated from the cancer-degenerated lacteal duct and have undergone some regressive metamorphosis during the migration in the intercellular lymph-channels, which has lessened their invading power. This conclusion is in agreement with the clinical fact that the eczematous change of the skin is almost always limited to the area surrounding the nipple. Only in very rare instances does it extend beyond the areolar region. Hammemuller and Landois assume that the chronic granulation tissue due to the long-continued cancerous invasion in the corium, is responsible for the degeneration of the epidermis, altering the osmosis and diosmosis of the cells. If this supposition is true, the second question is yet to be answered, viz.: Why is it that such a comparatively small number of cells change into Paget cells and increase their vitality while the surrounding epidermal cells do not show any transition to the former? Some authors believe that the transition of epidermal cells into Paget cells occurs frequently. However, I have noticed that epidermal cells often undergo vacuolation from the encroaching Paget cells, and at the same time lose the staining of the nuclei. If the sections are thin enough, it will be found also that in form they are quite different from the typical Paget cell. Figs. 7, 8 and 9 illustrate this difference clearly. In several instances I have found large clear cells of the basal-cell type, much like Paget cells, at the edge of cancerous ulcer of the lip. The same cell may be observed also in the neighboring epidermal layer of the naevocarcinoma, as has been noted by Audry, Hartzell and Kreibich. Such facts are proof that if cancer cells, which do not possess the tendency to cornification, migrate into the intercellular lymph-channels of the surrounding epidermal layer and suffer degeneration of their cell-bodies, they also may be similar to Paget cells. The same explanation may be applied to the findings in my case of extramammary Paget's disease. In the latter, the origin of the cancer was thought to be in the sweat glands or their ducts and the transition from glandular cancer cells into Paget cells at the edge of the ulcer was clearly observed. At the first step of the invasion into the normal skin layer, Paget cells act like foreign bodies, causing a stimulation which results in a proliferation of the epidermal cells and accounts for the thickness of the layer in such places. Afterward they increase in number by mitosis, migrate further, compress the normal epidermal cells, and finally destroy the skin layer to the ulcer.

In my fifth case, which was treated by the Röntgen ray, and in which the condition recurred after temporary healing in one spot of the areola, and was accompanied on its return by tumor formation in the deep layer, I found Paget cells in the recurrent, reddening part of the skin, and noted that the cells of the malpighian layer were degenerated

or destroyed. The explanation of this fact is, that while the migrating tumor-cells were almost exterminated by the Röntgen ray, some were left undisturbed in latent vitality, the intensity of which was recovered later and again caused the destruction of surrounding epidermal cells.

Next, we must study further the relation between Paget cells and melanoblasts. In many cases pigment cells are really increased in the border of the normal skin near the eczematous area. Moreover, in my fourth case, the integral pigment cells and the lumps of broken pigment were scattered in the mucous layer of the eczematous part where many Paget cells were collected in rows. Some of them contained bits of pigment which seemed to have been absorbed by the phagocytic action of the cells. There was no transitional form between the melanoblasts and the Paget cells. I could not find any positive evidence in any case to justify Kreibich's opinion that melanoblasts change into Paget cells, having lost the faculty of producing pigment and lipid.

The Corium.—The noticeable alterations in the corium are: (1) the infiltration of plasma cells, and (2) the hyperplasia of the elastic tissue. It is generally known that plasma cells are often to be seen in mammary tissue which is in physiologic condition, especially in the stroma surrounding acini. In Paget's disease the plasma-cell infiltration in many cases is remarkable in the subpapillary layer of the corium, *i.e.*, between the epidermal layer and the subpapillary elastic net, the latter forming the borderline of the infiltration (Fig. 10). Very often it extends to the deeper corium, below the borderline. The rows of cancer cells in the glandular part are sometimes enclosed by an annular infiltration. In the very early stage of this affection, however, there is often no noticeable infiltration of these cells. As a rule, the longer the duration of the disease, the stronger the plasma-cell infiltration. These cells are often mingled with lymphocytes, eosinophile cells or mast cells. When there is a mixed infection and polymorphoneutrophile cells invade the tissue in large numbers, the number of plasma cells seems to be decreased. The chief characteristics of plasma cells are the cytoplasm with basophilic granula, which are large, round and polygonal in shape, and eccentrically placed nuclei which are stained less densely by polychrome-methylene blue than cytoplasm. Little is known in regard to the matrices of the cells. Unna observed them in abundance in the connective tissue and about the vessel in cases of chronic inflammations, especially lupus. He assumes that they are derived from fibroblasts and destined to degenerate finally into epithelioid or even giant cells. Marshalko found them in normal tissue lying free in the lymph-glands and the spleen, and ascribed their origin to hæmic lymphocytes. He did not accept Unna's opinion that they are derived from connective-tissue

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cells, and change into epithelioid cells. Schottlander believes that plasma cells originate from hæmic elements while they resemble fibroblasts and might form granulation tissue and epithelioid cells. Hodera distinguished two kinds of so-called plasma cells—one, the true plasma cells, which are developed from the fixed connective-tissue cells, and the other, the pseudo-plasma cells, which are derived from hæmic elements. Krompecher claimed that plasma cells are an intermediate stage in the metamorphosis of wandering hæmic cells into fixed connective tissue. Ribbert insisted that plasma cells originate from normal minute lymph-nodes, which produce them abundantly when stimulated by some inflammation. Marchand suggested that plasma cells arise from the breaking up of large amœboid phagocytic cells, which in turn are developed in inflammatory conditions from adventitial cells. Whitfield claimed that the subdivision of the endothelium of the smallest central vessels of the lymph-nodes is the source of plasma cells. This problem cannot be solved with our present data. However, it seems to me that in some cases it is very probable that the plasma cells are derived from adventitial cells of vessel-walls, since in the early stage of the infiltration such a transitional development is no longer to be doubted. On the other hand, I am not ready to deny positively their hæmic origin. Many authors at present seem to accept a dual genesis of these cells.

I will consider now the hyperplasia of the elastic tissue. We sometimes note in slowly advancing, long-continued scirrhus carcinoma, a tremendous increase of elastic tissue, as if the entire stroma has changed (so-called elastocarcinoma). In Paget's disease the same phenomenon is often decided. The subpapillary elastic net, which in the normal condition occupies the borderline of the basal layer, is increased more or less under the eczematous area of the skin, and pushed down deeper by the plasma-cell infiltration, as I have already described. The most striking feature is seen in the corium of the nipple. The vertically-running elastic fibres sometimes take the place of muscle and connective tissue (Fig. 19). In the deeper subcutaneous layer, the elastic fibres show an increase in thickness and number, and here and there form thickly-stained irregular lumps. The cancer-degenerating milk ducts are usually encircled by a heavy ring of the elastica, which seems to have some defensive action against the proliferation of tumor cells. Granular degeneration of the elastica, as described by Fischer, is often noted. If we examine only the advanced stage of the increase in the elastica, we may receive the impression that it may have been formed from connective tissue and muscular tissue by metaplasia. As the result of careful study of various gradually advancing cases, however, I have been led to the conclusion that this tissue is increased, not by metaplasia, but

by continuous hyperplasia and hypertrophy of the pre-existing elastic fibres. Not only the subpapillary and subcutaneous elastic network, but more noticeably the elastic fibres contained physiologically in the walls of the milk ducts, vessels, the perimysium of the unstriated muscle fibres, and the perineurium of the subcutaneous nerves, by increasing, by branching and thickening, as a reaction against the slowly progressing, destructive agents, sometimes make overcompensation and substitute another tissue. The densely-stained elastic lumps which I have often seen in stroma could be traced in serial sections to degenerating unstriated muscles, vessels or nerves, which are replaced by elastica.

Lactiferous Ducts.—Interest from a pathologic standpoint centres in the condition of the lacteal duct. Since Thin assumed the affection to be primary milk-duct cancer, many authors (Hallopeau, Barling, Mandry, Jacobæus, Schambacher and others) have concurred in his opinion. Moreover, those who believed the affection to be superficial epithelioma (Vidal, Svetsitski and others) or precancerous disease (Wickham, Hartzell and others) observed proliferation of the lining cells of the superficial milk ducts even in very early stages of the disease (Jopson and Speese). To decide whether the alteration of the lacteal duct is primary or secondary, we must examine the condition in its very early stage, because in advanced cases the epidermis of the nipple is dropped off, and the condition of the superficial lacteal ducts is no longer distinguishable as the ducts have been replaced by cancerous granulation. In my observation of the early period—in one case for several weeks, in a second for seven months, in a third for ten months, and in three for one year after the eruption of the nipple—I always found a peculiar proliferation and desquamation of the duct epithelium in its superficial part, accompanied by irregularity of the shape of the cells. Fig. 14 gives undisputable proof that the proliferation of the duct epithelium is not secondary to the skin affection, but a primary cancerous degeneration of the orifice. The objection may be raised that the proliferating epithelium has not infiltrated into the surrounding stroma and caused alveolar formation. This, however, is due, first, to the early stage of the cancer development, and, second, to the peculiar anatomical structure and condition of the stroma of the nipple. The nipple, as is well known, contains many involuntary muscle fibres which not only give more resistance than connective tissue, but can be compensated by elastic tissue if it undergoes parenchymatous degeneration by invading cancer. This being true, the alveolar formation of cancer in the nipple in the early stage is particularly difficult as compared with a similar formation in the subcutaneous tissue of other parts. I examined frozen sections of the nipple from over one hundred cases, paying

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special attention to the superficial milk ducts in carcinoma of the breast, fibro-adenoma, and chronic cystic mastitis. In some cases, especially in mammary cancer located near the nipple, two types of reactive proliferation of the lining cells of the lacteal ducts were noted: (1) Villous proliferation of the epithelium only, and (2) papillary proliferation, *i.e.*, epithelial hyperplasia accompanied by connective-tissue increase. I have never found such epithelial proliferation with irregularity of cells and marked hyperplasia of the surrounding elastic tissue as is found in early Paget's disease. Although the source of stimulation in the former cases was in the deep layer and not in the outer skin, which some authors believe to be the case in a precancerous condition, the reactive phenomenon of the lacteal ducts in both cases seems to be analogous. Therefore, I should say that the epithelial alteration of the superficial lacteal ducts in early Paget's disease cannot be explained as being simply reactive proliferation due to stimulation, but in reality, is primary cancerous degeneration. In this disease the epithelium of the superficial lacteal ducts from the very beginning shows cancerous degeneration, which invades the epidermis, causing the skin affection, and the deep layer, forming typical cancer rows where the resistance and reaction of the stroma is weaker than that of the nipple (Fig. 17). This conclusion, which agrees with the observations of Jacobæus, is in agreement also with the clinical fact that in many cases the tumor formation takes place beneath the nipple about in the centre of the mammary gland, a clear space intervening between the affected skin and the tumor.

In general, the duct cancer is relatively less malignant, as it encroaches on the surrounding tissue slowly and metastasis occurs at a late stage. That Paget's disease may be a very slowly developing glandular-cell carcinoma from the superficial lacteal duct is not an unreasonable supposition. It is analogous to the basal-cell carcinoma which, as compared with the ordinary squamous-cell epithelioma, does not show distinct malignancy for some time. Some clinicians may oppose this opinion, since signs of cancer may be found clinically in the early, so-called eczematous stage of this affection. However, I dare say that five of my eighteen cases in which histologic examination revealed cancer of the superficial lacteal duct, were in just such an eczematous, so-called precancerous condition in which no clinical symptoms suggested the carcinoma. No longer can there be any question as to its nature, since Case X, even as early as a few weeks after the appearance of the eczematous patch, showed the beginning of cancer of the duct orifice. In this connection, still another point should be mentioned. The number of lacteal ducts showing cancerous degeneration of their lining cells is not large. In Case X the origin of cancer was limited distinctly to one

duct. Therefore, the entire area of the diseased nipple should always be studied by many serial sections or important facts may be overlooked in the examination of the early stage.

Case 6, in which the scrotum was affected by the disease, was in too advanced a condition to permit a decision as to the origin of the cancer. Nevertheless, the findings which showed that the cancer was of the glandular-cell type, containing lumina, and was invading the epidermal layer and changing into Paget cells, were similar to those in the cases in which the disease affected the breast, and it would not be absurd to suppose that the sudoriferous duct acted the part of the lacteal duct. Crocker, Rolleston, Hunt, and others, have already described the sweat glands as the origin of cancer in cases of extramammary Paget's disease. It is well known that embryologically the mammary glands and the sweat glands are similar. Recent authorities have concluded that embryologically the breast should be classed with the sweat glands, although the older writers believed that it was a modified sebaceous gland. Not only does the milk gland resemble the sweat gland closely in the manner in which it was developed, but in the adult condition its sudoriferous character is implied by (1) its hydradenoid structure, represented by the two-layered epithelium of the ducts and the simple epithelium in the glandular alveoli, and (2) the fact, that although in the milk gland there is no fatty metamorphosis of the central cells as in the sebaceous glands, there is a secretion from the gland-walls, as in the sweat glands. In the development of both glands, the deep layer of ependium (stratum cylindrosum) becomes thickened by the multiplication of its cells at the site of future glands, the thickened patch encroaching upon the underlying corium (Fig. 24). The epithelial ingrowth enlarges and cornifies gradually in its central portion, and part of it falls out, so that the ingrowth becomes hollow and changes into acini. Therefore, the epithelial cells in such a mammary bud may differentiate into two types with different functions, *i.e.*, the cover epithelium and the glandular epithelium. The superficial part of the ducts of these glands, especially of the lacteal ducts, shows a trace of this embryonic condition in the post-natal periods; the lining epithelium in this part shows either double-layered cylindrical cells or many-layered non-cornifying squamous cells. If carcinoma means the reversion of epithelial cells into undifferentiation *in loco*, it should be well understood that Paget's disease regarded as a primary glandular-cell cancer of the lactiferous duct shows some resemblance to cover-epithelial carcinoma.

From the above considerations, I am led to the opinion that *Paget's disease is primary carcinoma of the orifices of the lactiferous or the sudoriferous ducts.*

PAPILLOMA OF THE UMBILICUS*

BY NORMAN BRUCE CARSON, M.D.

OF ST. LOUIS, MO.

AN examination of the literature for papilloma of the umbilicus shows very few reported cases. Cullen, in his recent work, "The Umbilicus and Its Diseases," was able to collect only eleven well authenticated reports. Fabricius von Hilden, in 1526, published the first recorded case of this kind, and since then a few isolated cases only have been published, and most of these have not been considered reliable, because no microscopic examination had been made in the majority of them, and the gross picture was, therefore, not satisfactory.

Most of these tumors have been noted between the twenty-fifth and fiftieth years, although Broussolle reports a typical papilloma in a child five months old.

An examination of the reports shows that papillomata of the umbilicus occur in about equal frequency in the male and female, but Cullen does not consider the number, so far reported, of sufficient frequency to reach a definite conclusion in this regard.

As a rule these tumors are pedunculated, but in one reported by Péraire, the growth had spread out for a considerable distance into the abdominal wall.

These tumors are generally of slow growth, and vary in size from 5 mm. in diameter to that of a walnut, and are said to occur most frequently in persons of filthy habits.

In studying the recent work of Cullen, in which he has without doubt collected all, or most of the published reports, I am convinced that there must have been a number of these tumors which were not recognized as such, as diseases of the umbilicus have not received the attention that they were entitled to, until the publication of Cullen's very complete work on that subject. In my practice I have seen tumors in this situation, the diagnosis of which I have been unable to make, as no operation was allowed, because the tumors were small and giving no trouble.

The following case of papilloma of the umbilicus came into my service at the Barnard Free Skin and Cancer Hospital, last year, and on account of its rarity I have thought it of sufficient interest to report to-night.

* Read at the meeting of the St. Louis Surgical Society, October 11, 1916.

When the patient entered the hospital, the tumor was about the size of a hickory nut, of irregular surface, dipping down into the umbilical canal, giving it the appearance of growing around a tube. This surface was of a dark grayish color, and appeared like a large wart. The picture, here presented, taken at the time of entrance of the patient into the hospital, gives very distinctly the gross appearance of the tumor at that time.

History.—A. C., aged seventy-seven; male; occupation, laborer; white. Admitted to hospital October 25, 1915.

Past History.—Patient has always lived in the country, and done outdoor work. Has had three children, all of whom died in youth. No history of lues. Patient has always had good health, except one attack of jaundice and fever a few years ago.

Habits.—Irregular and filthy.

Present Illness.—About a year ago patient noticed a small mass, the size of a dime, at the umbilicus (Fig. 1). This has never ulcerated, has not been very painful, and there is no history of injury. Recently the tumor has been increasing in size, although the patient thinks it has been larger than it is at present.

Physical Examination.—Patient is a fairly well developed man. General appearance very anæmic. Mucous membranes are pale. General examination negative, except for a slight swelling of the right ankle. At the umbilicus there is a hard, irregular indurated mass surrounding the opening. This is not ulcerated, appears to extend deeply but does not seem to invade the surrounding tissue. There is no evidence of hernia, or other abdominal masses. The liver is about four finger breadths below the costal region; spleen not felt. Examination of rectum, negative.

Operation (October 28, 1915).—Region around the umbilicus was infiltrated with 1 per cent. novocaine. An elliptical incision about 5 cm. in length surrounding the tumor was made transversely across the abdomen. This was carried down to the peritoneum. It was found that the tumor did not extend into the abdomen, but seemed to be limited to the umbilicus. The peritoneum was opened, and a piece of omentum was found attached to the abdominal wall. An exploration of the abdomen did not reveal anything abnormal. The peritoneum was closed with a catgut suture; the fascial layer was overlapped from above downward, interrupted catgut sutures being used. The wound was closed with catgut and interrupted silkworm-gut sutures.

Post-operative Course.—Uneventful, except that the patient had a slight attack of arthritis in the right knee. The wound healed very satisfactorily, and the inflammation of the joint has had local treatment.



FIG. 1.—Papilloma of umbilicus.

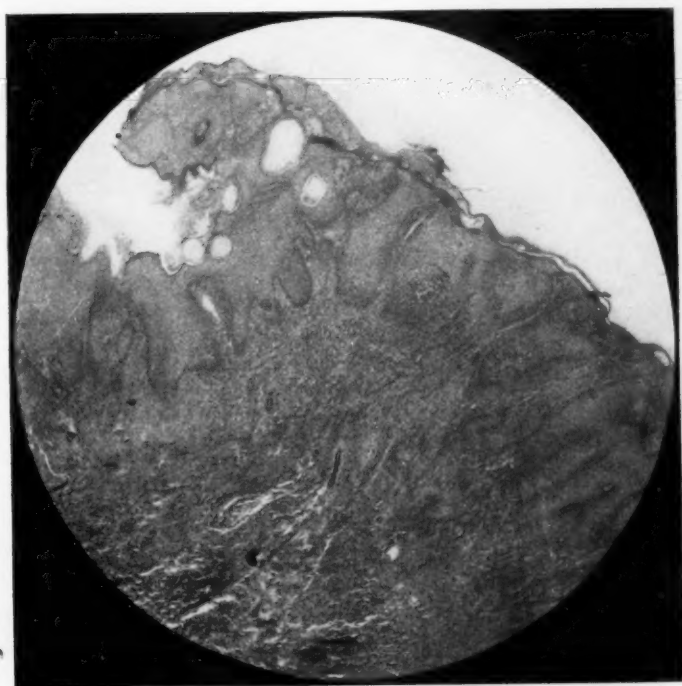


FIG. 2.—Microscopic section of papilloma of umbilicus.

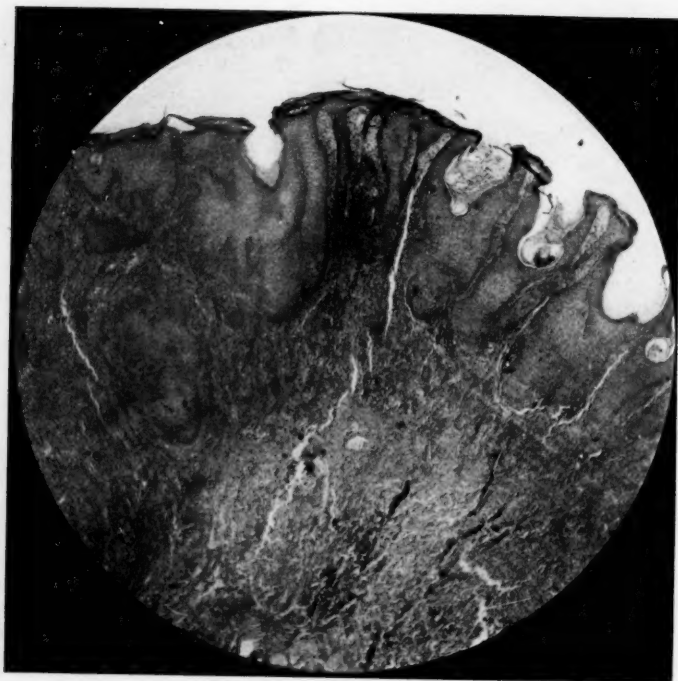


FIG. 3.—Microscopic section of papilloma of umbilicus.

PAPILLOMA OF THE UMBILICUS

Gross Pathology.—The tissue consists of an elliptical piece of skin 4 by 8 cm., which surrounds a papillomatous growth 2 by 2 cm. The surface of the growth extended down along the umbilical tract and seemed to be fairly well encapsulated. It does not seem to invade the surrounding tissue.

Microscopic Diagnosis.—Papilloma.

Microscopic Appearance (Figs. 2 and 3).—A section of the tumor under the microscope shows papillæ flattened on top as if they had been pressed down from above. The entire surface is covered with a number of unbroken layers of squamous epithelium, the superficial layers of which are hornified, but still maintain their identity by showing, here and there, a nucleus. There is also an occasional epithelial pearl to be seen. The papillæ themselves are enlarged and swollen, and extend down into the underlying connective tissue, which is much thickened and shows a high inflammatory process. This inflammatory process has involved several of the papillæ, and cut off a part of them, so as to make them appear like nests of epithelial cells.

The papillæ themselves are infiltrated with a large number of small round cells between the epithelial cells, a great many of which are eosinophiles, while some are polymorphonuclears.

Cullen classifies these tumors as benign and in a foot-note, on page 351, in his recent work, "The Umbilicus and Its Diseases," he says, "In the ordinary umbilical papilloma the growth is caused by a proliferation of the stroma—the squamous epithelium covering the papillæ occupies merely a passive rôle."

When the microscopic sections of this tumor are studied—microphotographs of which are here presented—one cannot help but see that his conclusions may be right, as it appears the stroma plays a very important part, quantitatively, in the development of this tumor, and that the epithelial enlargement in this case may really be a so-called precancerous condition.

I wish here to acknowledge my indebtedness to Dr. Cullen, in the preparation of this paper, as I have drawn largely on his recent, and very complete, work on this subject, and at times have quoted him verbatim.

THE HEALING OF GASTRO-INTESTINAL ANASTOMOSES

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IN 1905, while working out a method of aseptic intestinal anastomosis in Vienna, I took occasion to make a careful histological study of a series of gastro-enterostomies, which were performed during this series of experiments. The desirability of immediate publication of these observations was lessened by the appearance of Gould's² book, "Operations Upon the Intestines and Stomach," in which another series of preparations was pictured and described. Owing to brevity of Gould's account of the healing process, as well as a difference in the interpretation of some of its features, it has seemed desirable to publish an account of these observations.

The first published observations on the process of healing of gastro-enterostomies were made by Marchand³ who pictures and describes a single specimen six days old. From the preparations studied by Gould,⁴ the following conclusions were reached. After five days, the mucous membrane which has been injured during the operation sloughs and separates, leaving an ulcer with a floor covered by an exudate, at the edges of which one notes the beginning of regeneration of the mucosa from both the stomach and intestinal sides. This progresses so that the defect is completely covered by a low mucous membrane at the twenty-first day. In his specimens, he did not observe any regeneration of the muscularis mucosæ. A substitute for this layer of the intestine consists usually of connective tissue in which are found cells resembling smooth muscle in the later specimens. The muscle tunics, according to Gould, are held together by scar tissue arising from the intermuscular connective tissue which contracts and approximates the muscle ends so that the resulting scar may be scarcely recognizable by the naked eye.

Another series of specimens were studied by F. B. Murphy,⁵ in which the anastomosis was made by the McGraw ligature. This investigator was interested in problems associated with the technic of the operation, especially in the time taken for the opening of the stoma by the ligature rather than in the details of the healing process. Three stages of healing anastomoses are pictured by Murphy, in which it is interesting to observe the close parallel between the repara-

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tive process in specimens obtained by the ligature and suture methods notwithstanding the great difference in the operative technic.

The experiments were performed upon dogs under ether anaesthesia; the anterior operation was done for the obvious reason that it possesses the same advantages in four-footed animals that posterior gastro-enterostomy does in human beings.

The specimens from which the illustrations for this paper were drawn were obtained from operations in which two tiers of interrupted silk sutures were employed to make the anastomosis. In course of the experiments, other methods of suturing were also used for comparison, like the Wölfler technic of an outer interrupted tier, a continuous seromuscular and an inner mucosal stitch. The first two suture lines were of Pagenstecher or black silk, while the inner was of chromicized catgut. Operations were also performed by the Mayo method of an outer interrupted silk and an inner continuous catgut suture. The healing process by these different suture methods is approximately the same; variations occurring in the specimens according to the degree of operative traumatism inflicted rather than depending upon the types of sutures employed, although there may be a slight delay in healing due to the presence of the mucosal stitch. There developed, however, in course of the work problems associated with the use of the non-absorbable suture materials which will be discussed in a later paper.

The experimental animals were allowed to live for increasing periods of time, when they were anaesthetized, the anastomosis inspected in a living state, whereupon the animals were killed and the preparation removed. Both the stomach and the intestine were washed quickly with running water and then distended while still alive with Zenker's fluid. Thereupon, they were placed in vessels filled with the fixing fluid. In this way, the tissue was instantaneously killed and fixed, and the shrinkage, usually accompanying the ordinary methods of fixation of hollow viscera, was prevented. Sections were then made from different portions of the preparations, from which the following account of the healing process is taken.

The first gross evidence of the process may even be observed before the termination of the operation in a slight fibrinoplastic exudate, which tends to glue the serous surfaces of the stomach and intestine together, an observation previously made by Halsted⁶ and Mall⁷ in their studies of the healing of intestinal wounds. This union is, of course, of the most delicate nature, but it is, nevertheless, sufficient to seal the edges of the openings between the sutures uniting

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the two viscera. The next stage of the process lasts from 24 to 72 hours, and depends, apparently, in large part upon the location of the incision and the sutures with reference to the blood supply of the portions of the gastric and intestinal mucosa adjacent to the anastomosis. That is to say, if both of the flaps of mucous membrane after their section have a good blood supply, the healing process may take place in limited areas of anastomosis by what we are accustomed to call "first intention," namely, with a minimum of inflammatory

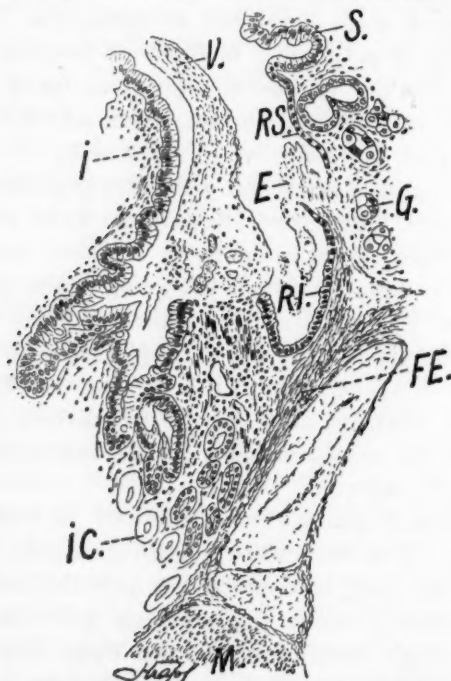


FIG. 1.—Section of the mucosa of a healing gastro-enterostomy twenty-four hours old. *I*, intestinal epithelium; *E*, fibrinoplastic exudate; *IC*, intestinal crypts; *G*, gastric glands; *FE*, fibrinoplastic exudate in the submucosa; *M*, cut end of the longitudinal layer of muscle of the intestine; *RI*, regenerating intestinal epithelium; *RS*, regenerating stomach epithelium; *V*, stroma of an injured villus.

reaction. If, on the other hand, there is an interference with the nutrition of the mucous membrane of the stomach or intestine adjacent to the opening by either the incision or the sutures, then the process of healing proper is preceded by an infiltration and partial necrosis of that portion of the mucosa which is deprived of its normal blood supply. The subsequent regeneration does not then occur until the line of demarcation is drawn between the injured and the healthy tissue. In general, we may say that the conditions of the operation seldom favor "per primam" healing even in parts of the anastomosis and never throughout its entire circumference.

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That these conditions should be exceptional follows from the researches of Mall⁸ and Disse⁹ upon the blood-vessels of the stomach and intestinal mucosa. According to these investigators, the arteries of the gastric mucosa and of the intestinal villi are practically end arteries, so that any interference with them leads either to an infarction or necrosis of the territory which they supply. As an evidence that this exceptional method of healing sometimes takes place, I may begin by describing one of my twenty-four-hour specimens before taking up consecutively the ordinary slower process, which forms the rule.

In this specimen (twenty-four hours, Fig. 1) the vessels had been cut so that there was practically no hemorrhage. Furthermore, the free ends of the muscular tunics of both viscera, freed from their tonus, had so contracted that the mucous membranes were brought nicely into apposition while the cut ends of the longitudinal and circular muscle layers of stomach and intestine were in consequence buried in the submucosa. There had been an immediate union of the serous surfaces by a slight fibrinoplastic exudate and only in the neighborhood of the stitch can one observe an infiltration of marked degree. At the time the animal was killed, the turned-in serous and muscular tunics gripped by the sutures are now joined by a thin layer of fibrin containing a few leucocytes which passes up as far as the incision in the mucosa. The muscularis mucosæ on both sides is somewhat retracted, but the longitudinal musculature of the intestine (Fig. 1, *M*) aids in filling the gap between the two cut ends of this thin sheet of muscle. This relationship is important as we shall find that the muscularis mucosæ is often partially regenerated from or substituted for by muscle derived from this source. At the point of incision in the mucosa there is a small plug of fibrin (Fig. 1, *E*) projecting for a short distance between the cut edges of the gastric and intestinal mucosa, while in the immediate neighborhood of the wound a few intestinal crypts and gastric glands show signs of degeneration. Notwithstanding, the regeneration of both stomach and intestinal epithelium has already begun. On the stomach side, the epithelium (Fig. 1, *RS*) from one of the adjacent gastric glands has undergone proliferation and extends as far as the tuft of fibrin, which projects from the submucosa at this point. This regenerative process may start from the epithelium at the mouths of the gastric glands or from the more highly organized epithelium forming the tubules, although in the latter case it ordinarily returns to its original undifferentiated embryonic form before the reparative process is inaugurated. From the development of the stomach mucosa, this is

what we might expect as the glands are formed by downgrowths of the epithelium which lines the simple digestive tube. In this reparative process, the high cylindrical character of the epithelium is lost and it becomes first cubical; then, as one proceeds to the edge where the youngest cells are formed, they become flattened to thin plates of protoplasm with oval flattened nuclei (Fig. 1, *RS*). In the few degenerating glands on the stomach side (Fig. 1, *G*), the chief cells are the first to lose their adult characteristics and undergo a hyaline degeneration, while the parietal cells hold their form for a longer period and appear much more resistant.

On the intestinal side of the anastomosis, a partly injured villus (Fig. 1, *V*) with an infarction of the tip is seen and the crypts belonging to it are slightly degenerated. From the tip of the villus, the epithelium has disappeared and the meshes of its stroma are filled with extravasated blood. Just above the base is a sharp line of demarcation, indicating that the region below is well nourished and will live.

From the fundus of the crypt at the side of the injured villus, the epithelium has, like that of the stomach, returned to its embryonic form (Fig. 1, *RI*) and is growing up on the opposite side of the sulcus formed by the projecting bit of fibrin (Fig. 1, *E*). Here it has already partly clothed the intestinal side of the unorganized fibrin with a layer of young flattened epithelium. At this period, there is no evidence that the presence of the acid gastric juice has had either any digestive or inhibitory action on the regeneration of the intestinal epithelium. The cells respond immediately to the injury and endeavor to clothe the denuded area at once, provided that they still retain their vitality. The future of such a portion of the anastomosis as is shown in this specimen can readily be imagined. In forty-eight hours or three days the surface of repair of the mucosa would be finished and there would only remain the further organization of the fibrinous exudate and the regeneration of the muscularis mucosæ to make the union as complete as is possible in such region. About the sutures, which are not absorbable, there would always naturally be such a reaction as is usually found around a foreign body, while at the point of junction between two dissimilar epithelia, a few bizarre epithelial cells would be seen, indicating the place where the two types of mucous membrane meet.

In contradistinction to the very unusual process outlined above, the ordinary reaction, at this stage (24 hours) is much more violent and depends, apparently, upon the injury to the circulation of the mucosa included between the inner tier of sutures. The anastomosis of both arteries and veins is rich in the deeper layers of the intestine

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and stomach and, consequently, readjustments are readily made. In the mucosa, on the other hand, this is not the case, moreover, it is this region of the operative terrain which has to bear the brunt of further injury in the passage of secretions and food from the stomach to the intestines through the new channel formed by the anastomosis. My experimental animals were given milk the day after operation and soft food on the third day, as I desired to see if the healing process would be materially retarded by the ordinary functions of the stomach.

In an average specimen of the anastomosis such as is shown in

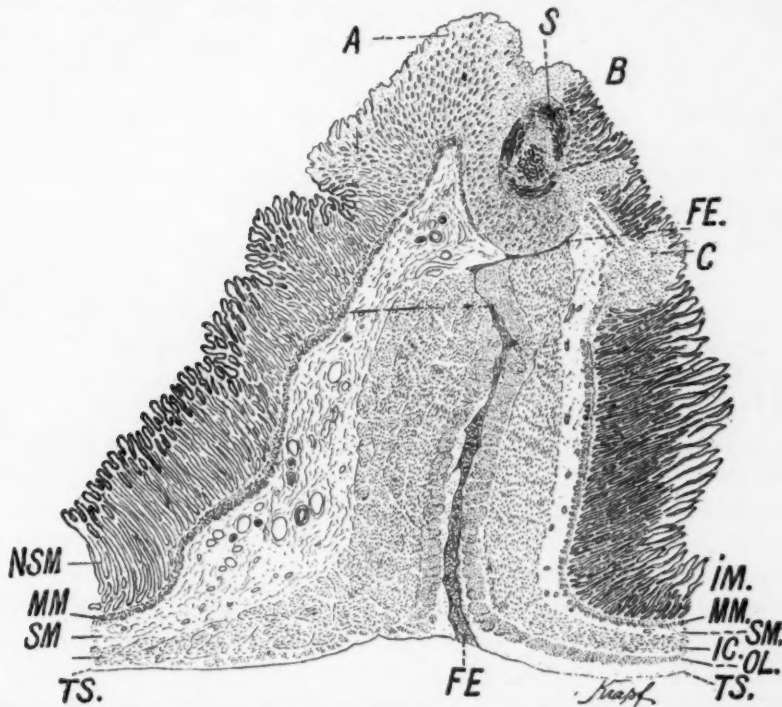


FIG. 2.—Section of gastro-enterostomy twenty-four hours old. *NSM*, gastric mucosa; *IM*, intestinal mucosa; *MM*, muscularis mucosae; *SM*, submucosa; *IC*, inner circular layer; *OL*, outer longitudinal layer; *TS*, tunica serosa; *FE*, fibrinoplastic exudate; *S*, stitch; *A*, degenerating gastric mucosa; *B*, degenerating intestinal mucosa; *C*, needle wound in the mucosa.

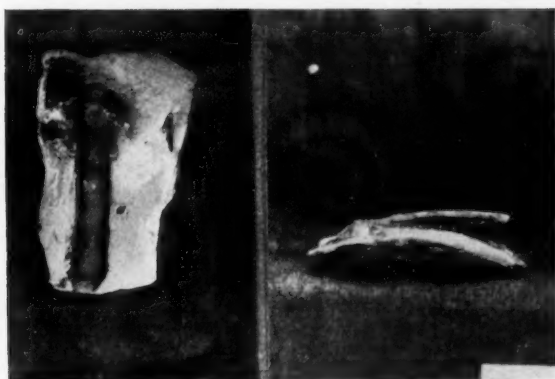
Fig. 2, the serous membranes are already adherent by a fibrinous exudate, containing numerous leucocytes and small round cells (Fig. 2, *FE*). The condition of the mucosa is normal a short distance from the point where the two types join. In the immediate neighborhood of the incision its condition must be looked upon as distinctly regressive, as the line of demarcation between that which is to persist and that which is to become necrotic has not yet become clear. This destructive process always precedes the inauguration of the regenera-

tive process. In this region at this stage, the traumatized mucous membrane of both stomach (Fig. 2, *A*) and the intestine is being partly digested by the gastric juice, as is shown by the pallor of the cells in the portion exposed to its action. The deeper layers are markedly infiltrated by leucocytes. In the degenerating fundus of the gastric glands, the chief cells are paler and have a more hyaline appearance than the parietal cells, which, though not by any means normal, seem more resistant than the chief cells. Their nuclei are darker and their cytoplasm retains its characteristic staining reaction longer than the other cells of the gastric glands. To the right of the line of section is a zone of the intestine (Fig. 2, *C*) that has been perforated by the needle and suture. Here, the muscularis mucosæ is ruptured and the intestinal mucosa is degenerating. At this point there is an intense reaction and infiltration by leucocytes and small round cells mixed with strands of fibrin. The muscularis mucosæ on both sides of the incision in the mucosa is retracted, leaving a zone of the submucosa unprotected. In consequence the cut end of the intestinal musculature rests directly against the degenerating mucosa.

In these average cases, the next few days shows a continuation of regressive process until the degeneration is complete and the organization of the exudate upon the necrotic mass begins. At the same time, the demarcation of the injured tissue is patent and, from the mucosa on either side of the exudate, regeneration begins. This stage is well shown in a seven-day specimen (Fig. 3). At this time the regressive changes have practically ceased and repair is fairly under way.

The serous membranes are now firmly united by the organization of the fibrinous exudate, the cells of which pass in between the bundles of longitudinal muscle fibres. On either side of the wound, the mucous membranes are sharply differentiated and the necrosis of the poorly nourished portion is not only complete, but the regeneration of the portion which was injured but not destroyed has been practically accomplished. In this region of minimum reaction, the stroma is clothed with a new epithelium somewhat younger and lower than that of the normal stomach, while the injured bases of the adjacent villi on the intestinal side are also covered with an epithelial layer, less differentiated in character than that of the normal intestine. This region is shown in the drawing (Fig. 3) by the thinning of the epithelium and its loss of villi. The exudate over the site of the wound in the mucosa is partly organized and the healing of the defect is progressing both from the gastric and the intestinal sides of the anastomosis. The villi and the gastric glands that lost their epithelium have both received a new coat, while the epithelium of the

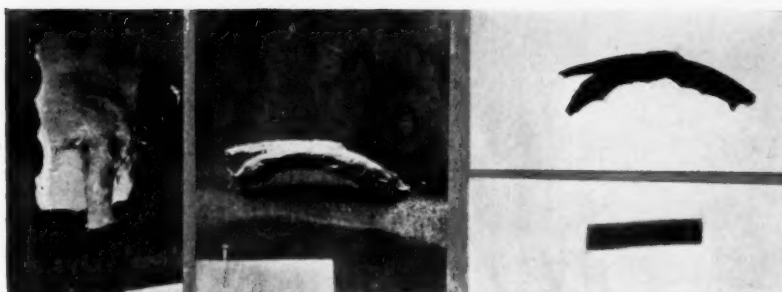
FIG. 1A.



1

2

FIG. 1B.



1

2

4

3

FIG. 1.—Experiment D4. Cartilage with perichondrium, rib without periosteum, each 2 cm. long when transplanted. Eighty-five days after transplantation. *A*, cartilage, still 2 cm. long. 1, from above; 2, profile view. *B*, bone, scant 2 cm. long. 1, from above; 2, profile view; 3, profile view, X-ray; 4, control rib, 2 cm. long. *B*, 1, shows excessive bone formation around impinging portion of transplant. Note absorption of bone on free extremity shown in *B*, 3, when compared to control.

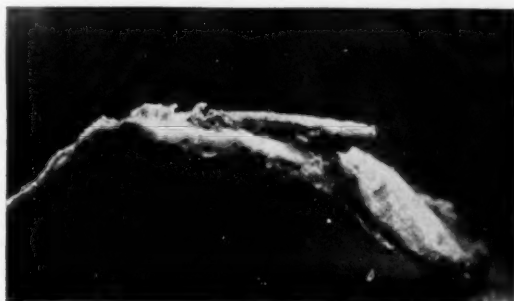


FIG. 2.—Experiment D3. Cartilage with perichondrium, 2 cm. long, when transplanted. Two hundred twenty-three days after transplantation. The cartilage is still 2 cm. long. The rib transplant without periosteum in this experiment had been absorbed.

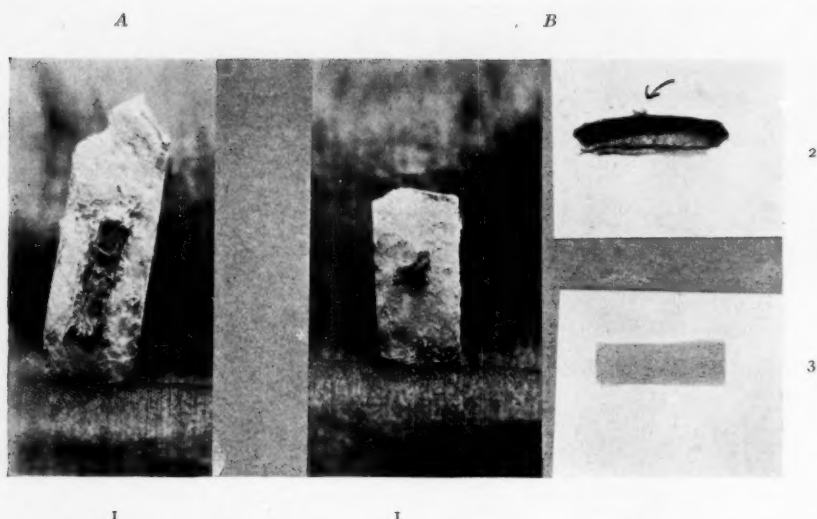


FIG. 3.—Experiment D1. Cartilage with perichondrium, rib without periosteum, each 2 cm. long when transplanted. Five hundred seventy-six days after transplantation. *A*, cartilage, still 2 cm. long. 1, from above. The specimen had dried out before this photograph was taken. *B*, bone, small nubbin, 2 mm. long. 1, from above; 2, profile view, X-ray; 3, control rib, 2 cm. long. Note comparative size of remaining bone with control.

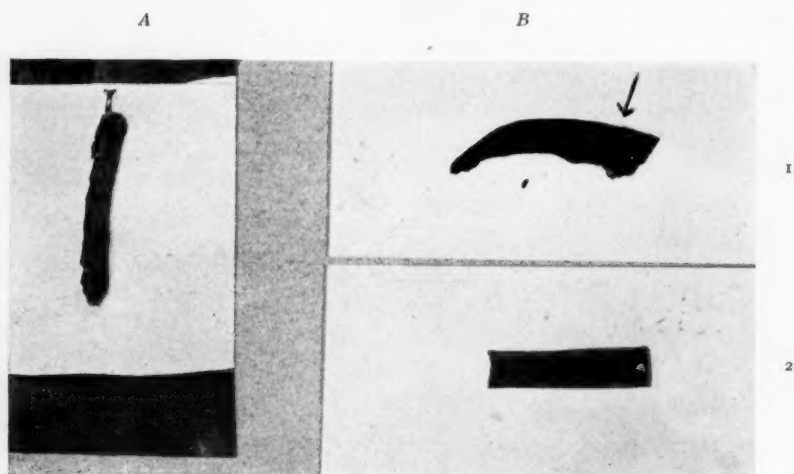


FIG. 4.—Experiment D5. Cartilage with perichondrium, rib without periosteum, each 2 cm. long when transplanted. Five hundred eighty-two days after transplantation. *A*, cartilage, still 2 cm. long. *B*, bone, small nubbin, .5 mm. long on parietal bone. 1, profile view, X-ray; 2, control rib, 2 cm. long. Note amount of absorption when compared with the control.

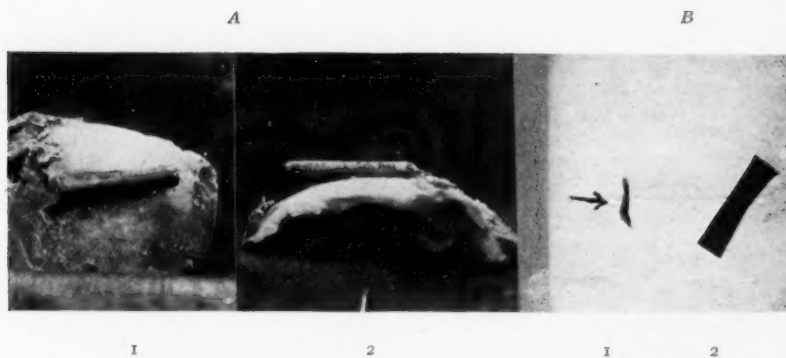


FIG. 5.—Experiment D0. Cartilage with one-half perichondrium, rib without periosteum, each 2 cm. long when transplanted. One hundred twenty-five days after transplantation. *A*, cartilage, still 2 cm. long. 1, from above; 2, profile view. *B*, bone 1 cm. long, thin and irregular. 1, X-ray of transplant; 2, X-ray of control bone, 2 cm. long. Note good condition of cartilage and great amount of absorption of bone when compared with the control.

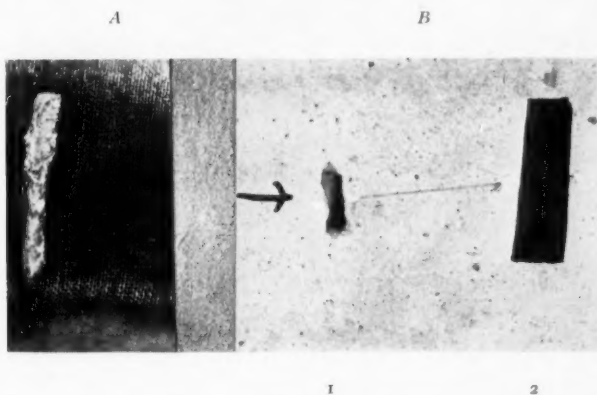


FIG. 6.—Experiment D13. Cartilage with one-half perichondrium, rib without periosteum, each 2 cm. long when transplanted. Three hundred seventy-four days after transplantation. *A*, cartilage, still 2 cm. long. *B*, bone, 8 mm. long, thin and irregular. 1, X-ray of transplant; 2, X-ray of control, 2 cm. long. Note absorption of bone.

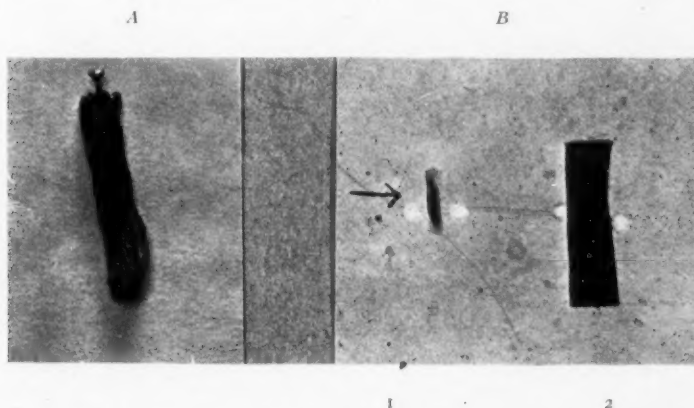


FIG. 7.—Experiment D8. Cartilage with one-half perichondrium, rib without periosteum, each 2 cm. long when transplanted. Five hundred five days after transplantation. *A*, cartilage, still 2 cm. long, and in good condition. *B*, bone 7 mm. long, thin and irregular. 1, X-ray of transplant; 2, X-ray of control, 2 cm. long. Note bone absorption.

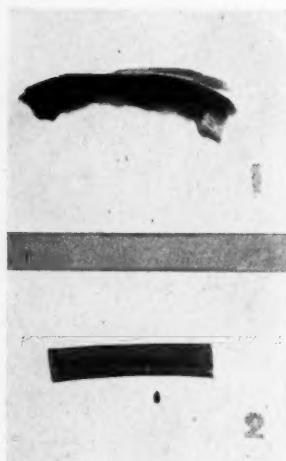


FIG. 8.—Experiment D12. Cartilage without perichondrium, rib with strip of periosteum, each 2 cm. long when transplanted. Fifty-six days after transplantation. Bone, 1.6 cm. long. 1, X-ray of transplant; 2, X-ray of control 2 cm. long. Note absorption. The cartilage in this experiment was unchanged.

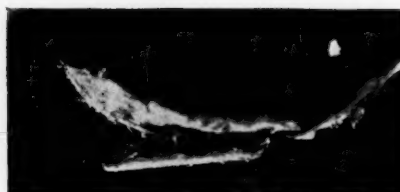


FIG. 9.—Experiment D16. Cartilage without perichondrium, rib with strip of periosteum, each 2 cm. long when transplanted. One hundred sixty-five days after transplantation. Cartilage still 2 cm. long, although not in contact with the skull. The bone in this experiment had been absorbed.

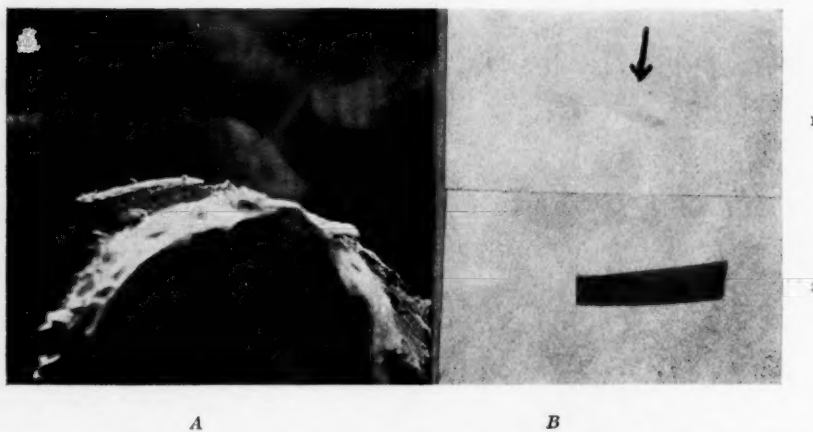


FIG. 10.—Experiment D17. Cartilage without perichondrium, rib with strip of periosteum, each 2 cm. long when transplanted. Three hundred thirty-two days after transplantation. A, cartilage, still 2 cm. long. B, bone, very thin, 7 mm. long. 1, X-ray of transplant; 2, X-ray of control, 2 cm. long. Note absorption of bone.

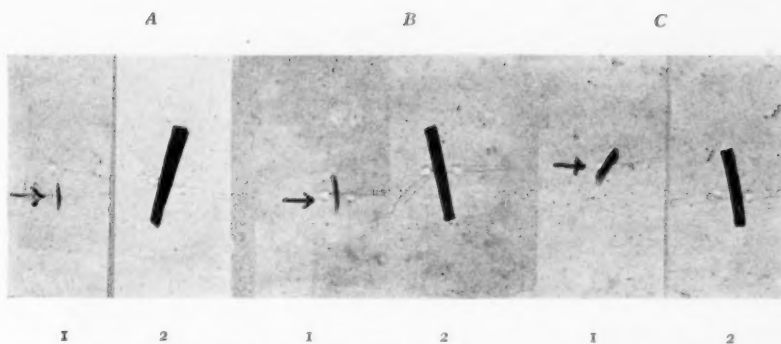
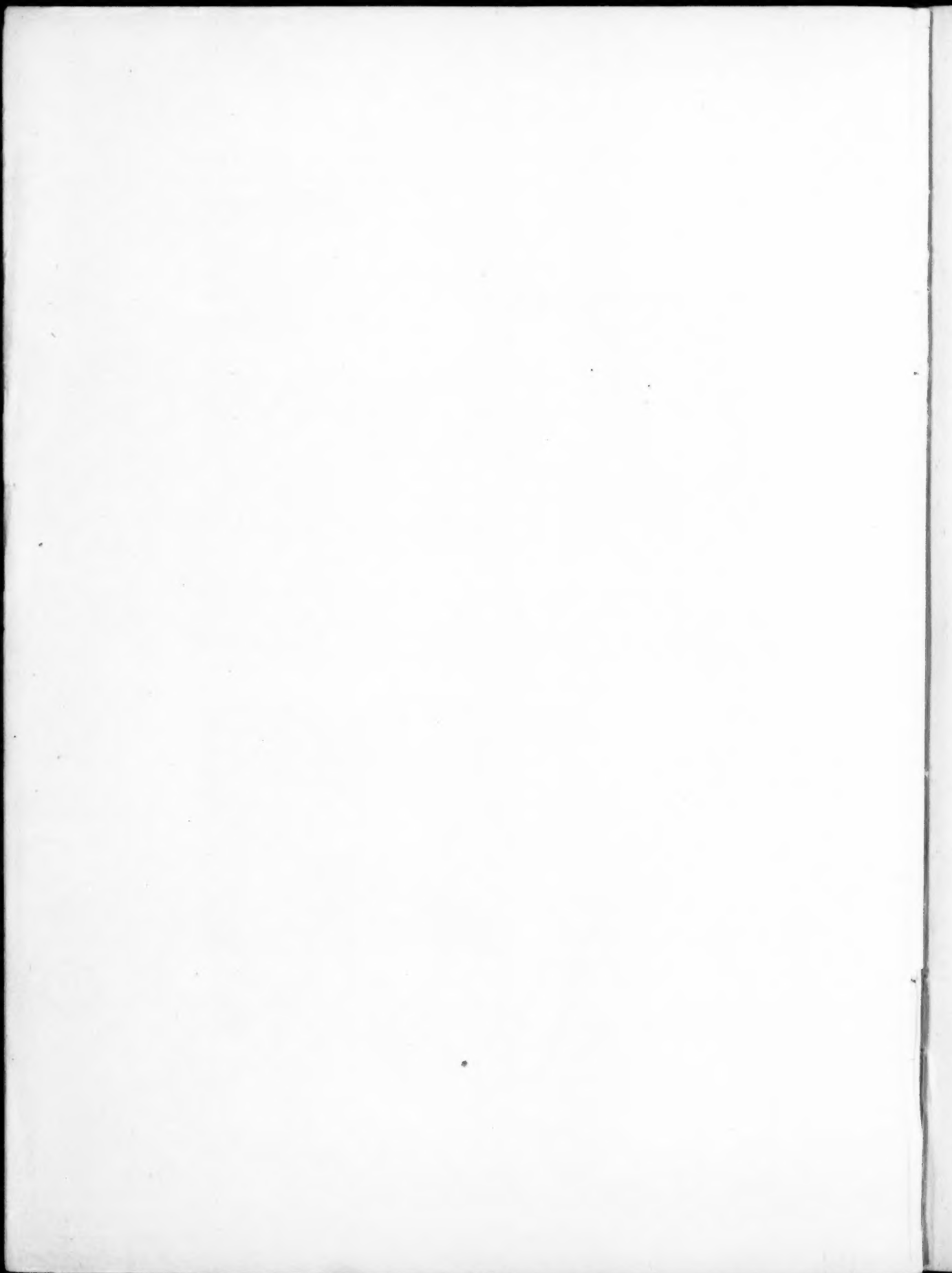


FIG. 11.—Experiments D18, 19 and 20. Fibula with and without periosteum. A, after three hundred five days. 1, X-ray of fibula transplant with periosteum 5 mm. long; 2, control fibula, 1.8 cm. long. B, after three hundred twenty-eight days. 1, X-ray of fibula transplant with periosteum, 8 mm. long; 2, control fibula, 1.75 cm. long. C, after three hundred eighty-eight days. 1, X-ray of fibula transplant with periosteum, 7 mm. long; 2, control fibula, 1.4 cm. long. The sections of fibula without periosteum in each of these experiments had been absorbed. Note amount of absorption of the transplants covered with periosteum when compared with the controls.



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mouths of the gastric glands, on the one hand, and from the epithelium of Lieberkühn's crypts, on the other, cells have grown out to cover the partly organized exudate. From the stomach side, the epithelium rapidly flattens as it passes down into the invagination (Figs. 3 and 4, *RS*) between the mucosa and mounts up on the exudate. Here it is in the form of flat cells that bear absolutely no resemblance to the high columnar cells which gave rise to them.

As the new formed layer approaches the edge of the organized

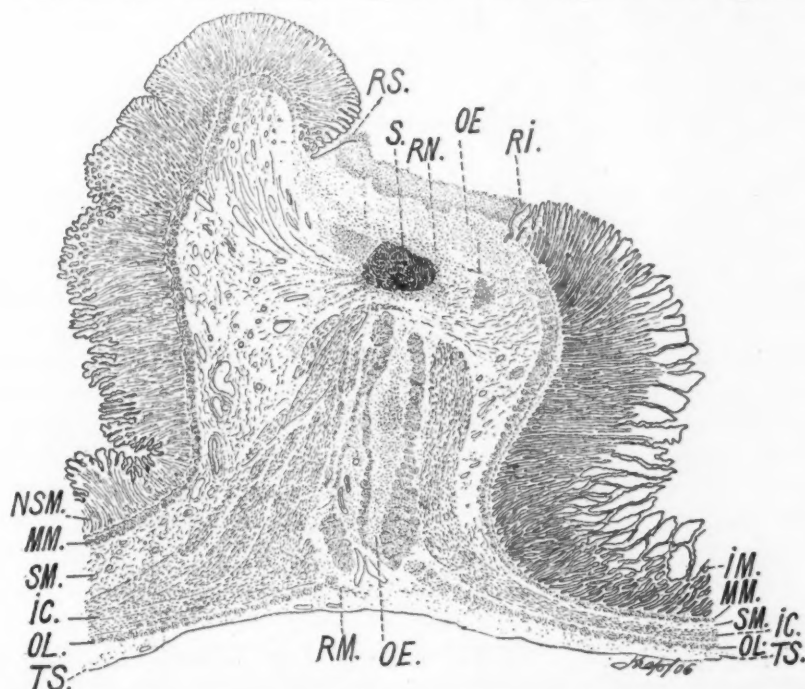


FIG. 3.—Section of a gastro-enterostomy seven days old. *RS*, regenerating gastric mucosa; *RI*, regenerating intestinal epithelium; *OE*, organizing exudate; *S*, stitch; *RN*, regenerating muscularis mucosae; *NSM*, normal gastric mucosa; *IM*, normal intestinal mucosa; *MM*, muscularis mucosae; *SM*, submucosa; *IC*, inner circular layer; *OL*, outer longitudinal layer; *TS*, tunica serosa; *RM*, regenerating longitudinal musculature.

exudate, it penetrates its substance instead of growing up on its surface. This overlapping of the exudate (Fig. 4, *A*) possibly serves to protect the youngest cells from the gastric juice. There are a number of karyokinetic figures in the epithelium from the mouths of the gastric glands as well as in the embryonic glands in the neighborhood of the sulcus that separates the exudate from the regenerating portion of the mucous membrane (Fig. 4, *RS*). In this zone, the glands have returned to their embryonic form, that is to say, they have no differentiated cells, but are lined with a layer of low columnar or cubical cells. There is no distinction between chief and parietal cells.

On the intestinal side, there is, as on the gastric side, a zone where the mucosa has been injured but not destroyed. This region is characterized chiefly by a loss of the villi (Figs. 3 and 5, *RI*) and the presence of a series of crypts that have returned to their embryonic form, that is to say, crypts that show little or no differentiation in

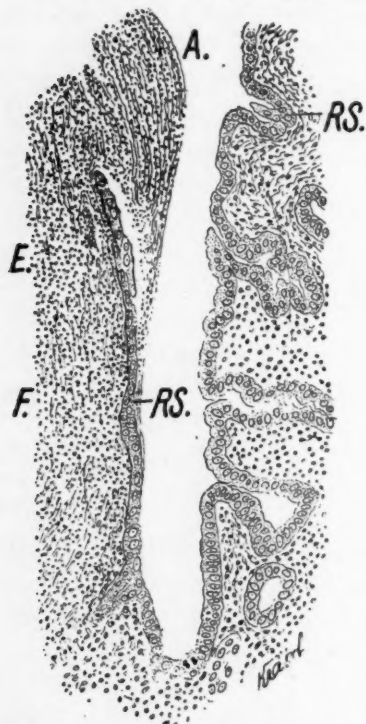


FIG. 4.—Section of the zone between the regenerating mucosa of the stomach and the organizing exudate. Same preparation as Fig. 3. *RS.*, regenerating gastric epithelium; *A.*, exudate overlapping the young epithelium; *E.*, organizing exudate.

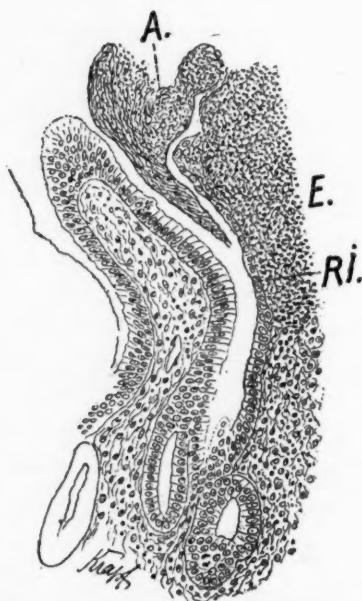


FIG. 5.—Section of the zone between the regenerating intestinal epithelium and the organizing exudate. Same preparation as Fig. 3. *E.*, organizing exudate; *RI.*, regenerating intestinal epithelium.

the epithelium that clothes them. They are lined by a low columnar epithelium showing very few or no goblet cells.

At some points, the first stages of the differentiation of the goblet cells from the embryonic form of epithelium may be made out. Karyokinetic figures are often seen in the epithelium of these young crypts. As the zone of maximum injury in the neighborhood of the wound is approached, the columnar form of epithelium rapidly flattens and as it passes over the sulcus between the healing mucosa and up on the exudate (Fig. 5, *RI*), like that of the stomach, it becomes extremely flat. It penetrates the substance of the exudate (Fig. 5, *A*)

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and gives, in sections, the appearance of being overhung by a flap of the exudate mass. Here the cells are of irregular flattened form with fairly large vesicular nuclei (Fig. 5).

The exudate is now composed of a mass of young connective tissue cells containing a great deal of detritus and cellular debris. There is naturally also a quantity of round cells and leucocytes in the mass as well as numerous young blood-vessels. Here and there one sees pale cells with large round nuclei and a considerable amount of protoplasm, which stains densely with acid dyes. These appear to be the shadows of epithelial cells originating from necrotic glands of the stomach and intestine. Either they have not entirely lost their vitality, or are regenerating in the rapidly organizing exudate, from a few rests of the old glands.

Immediately under the exudate there is a group of young muscle fibres extending from the region of the Muscularis mucosæ in the intestine to the cut end of the same layer in the stomach. This is probably a case of precocious regeneration, for I possess older stages where the muscularis mucosæ is not being so completely restored. However, it also appears probable from my specimens that, in certain instances, muscle cells may be derived from the cut ends of the muscle tunics of the intestine or stomach, which aid in the reestablishment of the muscularis mucosæ. At the lower angle of the enfolded serosa there are already distinct evidences of the regeneration of the muscular tunics over the gap between the stomach and intestine (Fig. 3, *RM*) now occupied by young fibrous tissue. These young muscle cells appear to spring principally from the outer oblique fibres of the stomach. This cannot be looked upon, however, as a constant accompaniment of the healing process, as I possess later stages where the healing is complete without this gap being bridged by muscle fibres at all. But while the process does not invariably occur about the entire anastomosis, it may be present in one portion and not in another. It appears probable that this regeneration may be associated with a tearing of the outer muscular coats of both stomach and intestine by the outer row of sutures. From the broken ends of the muscle bundles the new regenerating elements are formed. It is possible that the direction of the muscle pull during peristalsis of anastomosed viscera may be an influencing factor. This contraction with partial fixation of the muscle by sutures may aid in liberating the muscle bundles so that the regeneration can take place on the free end.

Fourteen Days.—At this stage there is now little evidence of the inflammatory reaction save in the immediate neighborhood of the

stitches (Fig. 6, *S*). The break in the mucosa has healed over so that the passage between the lumina of stomach and intestine is now lined by a continuous layer of mucous membrane (Figs. 6 and 7). In the zone of minor injury, where the mucosa was not entirely destroyed, the repair process is well advanced, for, on the stomach side, one sees a group of young gastric glands developing apparently along embryological lines (Fig. 6, *RS*). By this is meant a group of glands now differentiated into mouth and crypt or tubule, but young in the sense that they have principally chief cells for their lining, while showing only here and there parietal cells interpolated between the chief cells in the position where they differentiate from the indifferent embryonic cells that line the young glands.

On the intestinal side of the wound the tissue in the zone of minor injury (Fig. 6, *RI*) consists of a series of embryonic crypts surmounted by slight projections suggestive of young villi. In this region some of the crypts contain goblet cells, but they are by no means as numerous as in the healthy mucosa.

In the regenerated portion of the mucosa over the zone of maximum injury there are infoldings of the epithelium from young crypts on the intestinal side and gland on the stomach side. The new membrane has, however, by no means reached the normal thickness. On the stomach side, the cells (Fig. 7, *RS*) are high like those lining the mouth pieces of the gastric glands, while those on the intestinal side (Fig. 7, *RI*) contain a much larger percentage of goblet cells than is the case in my other and even much older preparation.

The line of demarcation between the two types of epithelium is absolutely sharp, as differentiation is possible to the point where the last stomach cell ends and the first intestinal cell begins. In this particular case, owing to the presence of the goblet cells, the darker staining gastric mucosa affords a particularly sharp contrast to the lighter colored intestinal epithelium. Here, too, are missing the few abnormally formed cells which usually occur on either side of the meeting point of the regenerated epithelia (Fig. 11, *A*). The reaction has disappeared from the region of the mucosa. The muscularis mucosæ has partially regenerated from each side (Fig. 6, *RN*) and the intervening gap is filled in by a portion of the muscle from the circular and longitudinal layers of the intestine (Fig. 6). The organized exudate observed between the longitudinal muscle of both organs in the preceding stage has been transformed into connective tissue except in the neighborhood of the sutures, where a dense infiltration still exists. Here, in the meshes of the silk fibres, are found young connective tissue cells and numerous leucocytes. Nearby

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foreign body giant cells may be seen. These are also to be seen in the interspaces between the muscle bundles at some distance from sutures.

Twenty-three Days.—At this stage the repair is so far advanced

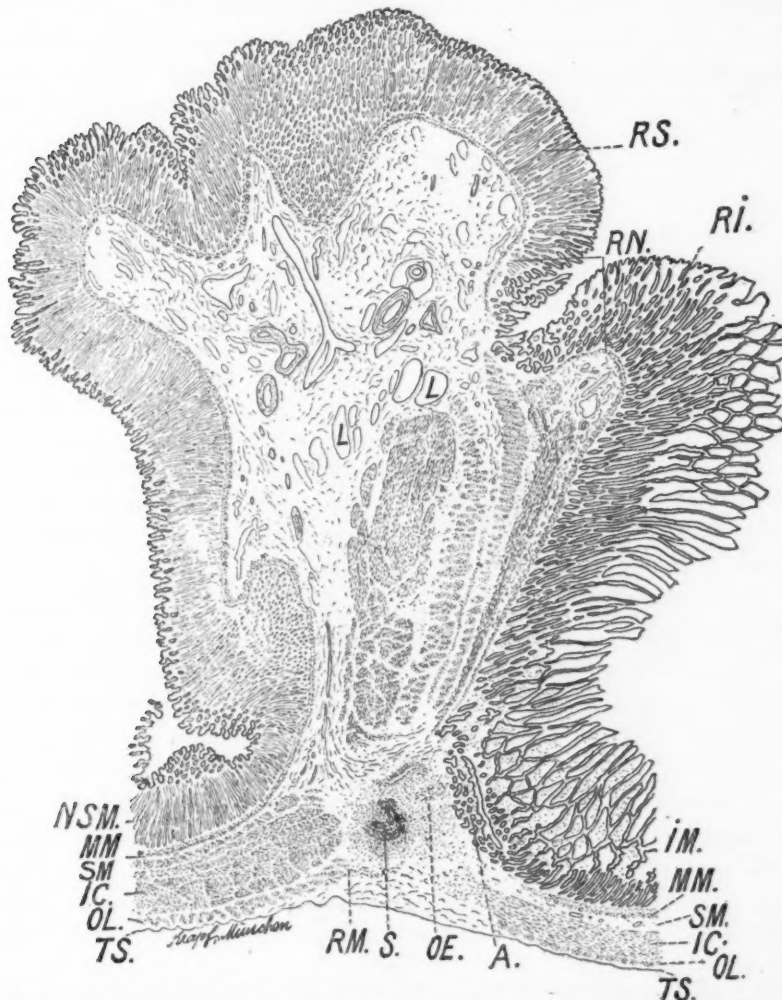


FIG. 6.—Section of gastro-enterostomy fourteen days old. NSM, normal gastric mucosa; IM, intestinal mucosa; MM, muscularis mucosae; SM, submucosa; IC, inner circular layer of muscle; OL, outer longitudinal muscular layer; TS, tunica serosa; RS, regenerating gastric mucosa; RI, regenerating intestinal mucosa; RN, regenerating muscularis mucosae; RM, regenerating muscular tunic; S, stitch; OE, organized exudate; A, ingrowth of Lieberkühn's crypts following injury to the muscularis mucosae.

that the apposition of normally different types of epithelium may, with the presence of the stitches, be the only thing which gives obvious evidence of the anastomosis. The study of the preparation with the higher powers shows, however, that numerous abnormalities are present. On the whole, the condition of the anastomosis at this stage

naturally depends on the amount of injury done to the tissue at the point where the operation was performed. If the injury was minimum, both stomach and intestinal mucosa may be practically normal within a short distance of the point of union, where a group of bizarre cells occur in both types of epithelium. If the injury is excessive there, there is a zone where mucosa is abnormal, that is to say, where

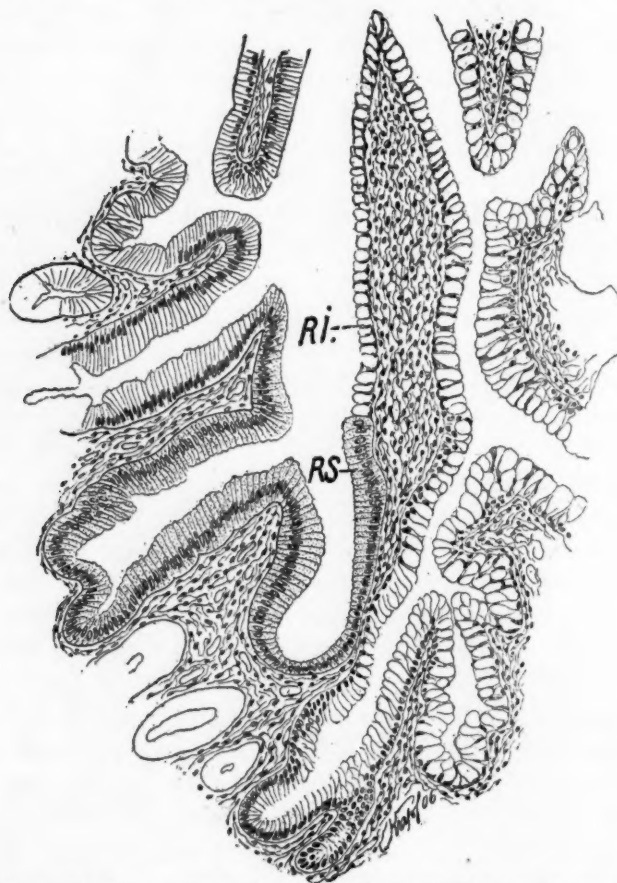


FIG. 7.—Zone of junction of the gastric and intestinal epithelium from the fourteen-day preparation shown in Fig. 6. *RI*, regenerating intestinal epithelium; *RS*, regenerating gastric epithelium.

it persists in its more embryonic form until the slower process of differentiation takes place. Naturally, there are, in most anastomoses, points where both conditions obtain, as the mucosa may suffer greater injury at one point than at another. In consequence, the healing is often more advanced in some regions than in others. In one of my preparations, at this stage, the healing may be said to be complete. The continuity of the mucosa is reestablished and well formed crypts and villi are found next to practically normal gastric glands.

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The muscularis mucosæ has regenerated over the gap, partly from the stomach side, partly from the intestinal side, and partly by the contribution of a few fibres from the inner circular layer of muscle of the intestine. The infolded muscular coats of both stomach and intestine have grown firmly together by means of the connective tissue derived from the fibrinoplastic exudate, which sealed the two viscera at the time of the operation. About the suture, there is a mass of fibrous tissue containing some foreign body giant cells.

Thirty and Forty Days.—In these specimens the healing of the submucosa and muscular tunics is usually complete or well advanced, although the degree to which the tunica muscularis is restored depends both upon the position of the section and the condition of the involved layers. In the thirty-day specimen shown in Fig. 8, the continuity of the infolded longitudinal muscle has been broken by the stitch and, in consequence, the circular muscle is well regenerated beneath it. Likewise a few bundles from the outer longitudinal coats have begun to bridge the gaps filled by the organized fibrous tissues which join the tunics in the younger layers.

The muscularis mucosæ has regenerated from both sides but is very thin. It is, however, strengthened by fibres derived from the cut end of the outer longitudinal muscular tunic of the intestine, making complete the muscular foundation upon which the mucosa rests. At the site of the incision in the mucosæ, there is still an irregular fold as these layers have not regenerated to their usual thickness.

On the intestinal side the crypts are practically normal except in the absence of the usual numbers of the goblet cells. The villi that have been destroyed appear to be regenerating (Fig. 8), as there are short irregular elevations from the general level of the mucous membrane containing the stroma of villi and covered by an epithelium slightly lower than that of the adjacent normal structures. On the stomach side there are numerous young glands already well differentiated into mouthpiece and tubule, but still lacking the requisite number of parietal cells to give them the typical character of the adult gastric glands. Here and there, however, they may be seen developing from the epithelium lining the tubules. They appear as cells with a slightly greater acidophilic reaction to their cytoplasm, which in the subsequent development of the tubule became shunted off to the side, where they take up their final normal peripheral position in the gland.

Fifty-five Days.—In this stage as in the earlier preparations the healing is complete but the entire restoration of the mucous membranes depends to a great extent upon the degree of the injury. The regeneration in my preparations of this period appears in places to have

been retarded by the necessity of an extensive repair. So far as the function of the anastomosis is concerned, the entire opening between the two viscera has long been clothed by a mucous membrane of normal thickness. The preparation shows the complete transformation of all the exudate into connective tissue except in the region of the stitches (Fig. 9, *S*) where numerous round cells and a few foreign body giant cells occur in the framework. The gap between the two infolded layers of muscle in this preparation is not bridged by any newly formed fibres, but the connective tissue keeps them effectually together.

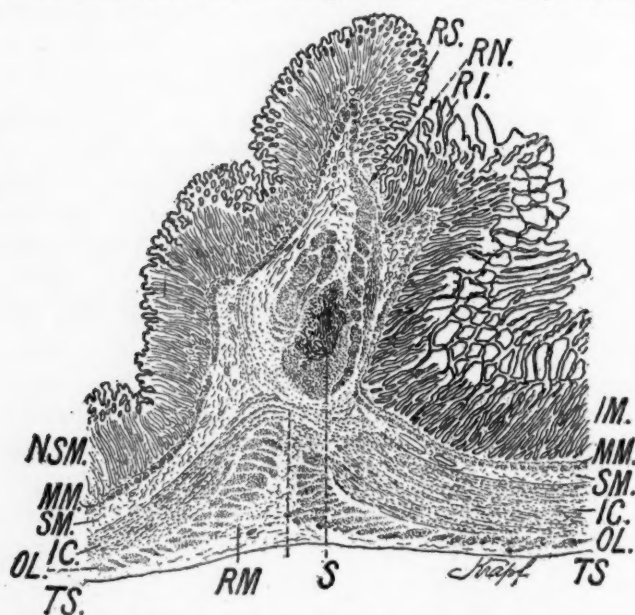


FIG. 8.—Section of gastro-enterostomy thirty days old. *RS*, regenerating gastric mucosa; *RI*, regenerating intestinal mucosa; *RN*, regenerating muscularis mucosae; *NSM*, normal gastric mucosa.

The muscularis mucosæ likewise (Fig. 9, *RN*) does not form a complete layer under the mucosa but is partly compensated for by bundles of muscle derived from the circular layer of the stomach. The presence of a stitch (Fig. 9, *S*) at this point has apparently prevented the regeneration of this muscular sheet, but it also provided a firm enough floor to prevent the ingrowth of the glands and crypts into the region of the submucosa. In the mucosa there is a practical restoration of the original thickness of the mucous membrane except at the site of the wound, where an irregular depression occurs.

This is probably the result of the presence of the stitch, as my other sections of this anastomosis show the normal thickness of the mucosa in this region. But, notwithstanding, on the intestinal side

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a number of villi remain to be regenerated, while on the stomach side of the wound glands are not entirely differentiated as is shown by the absence of parietal cells in many of them. That the regeneration is in progress is shown by the presence of karyokinetic figures and by the fact that from the site of the wound in the mucosa, where the glands are youngest, they take on a progressively older character as one proceeds to the zone of the uninjured mucosa. From glands without parietal cells, those partially provided with them are at first encountered while further out they become completely normal.

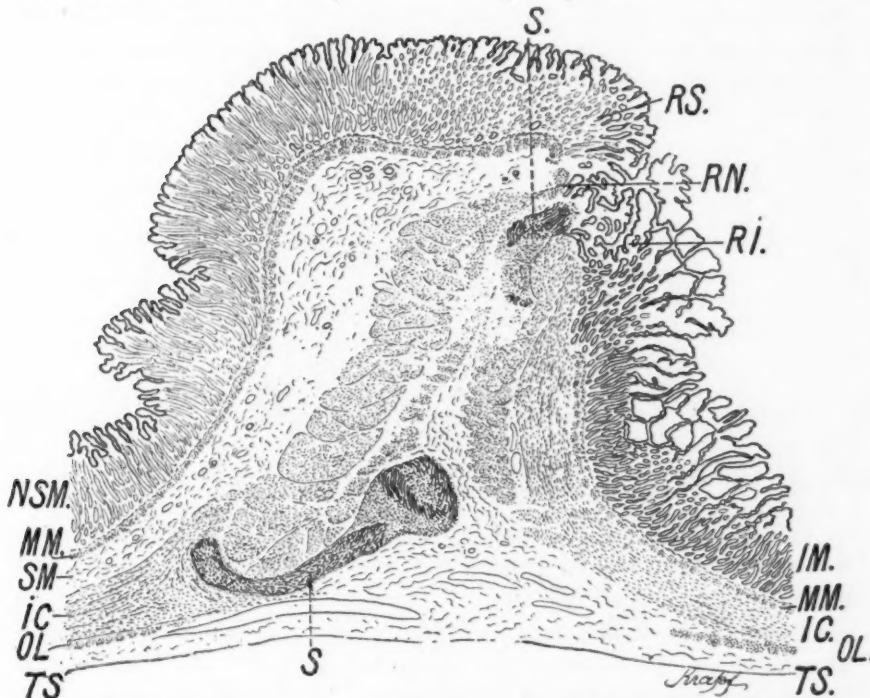


FIG. 9.—Section of a gastro-enterostomy fifty-five days old. *RS.*, regenerating gastric mucosa; *RI.*, regenerating intestinal mucosa; *RN.*, regenerating muscularis mucosae; *S.*, stitch; *NSM.*, normal gastric mucosa; *IM.*, intestinal mucosa; *MM.*, muscularis mucosae; *SM.*, submucosa; *IC.*, inner circular muscular layer; *OL.*, outer longitudinal layer; *TS.*, tunica serosa.

The means by which this restoration of the gastric glands takes place occurs as follows: The young elements are formed from rests of glands in this zone of minimum injury, and from the invagination of the epithelium that grows out on the exudate; subsequently they differentiate into mouthpiece and tubule.

From the low columnar epithelium that lines them, cells appear that show a distinct acidophilic reaction in their cytoplasm. These begin to grow larger but they still maintain, however, their position in the same plane as the other cells of the gland (Fig. 10, *P*). As the

differentiation proceeds, they increase in size and are gradually pushed back to the side of the tubule where they take up their final adult position. This method of differentiation, of course, is similar to that by which the parietal cells are produced in the embryo.

Figure 11 shows the segment of the healed mucosa fifty-five days old just over the site of the incision in the two mucous layers. On the intestinal side, the crypts (Fig. 11, C) are now clothed with a columnar epithelium in which the differentiation of the goblet cells has to a great extent taken place. Here and there in the fundus and the sides of the crypts, karyokinetic figures are found. Projections from the surface of the mucosa indicate the formation of the new villi.

On the stomach side, the gastric glands are still young and show only the differentiation into mouthpiece and tubule. In the glands

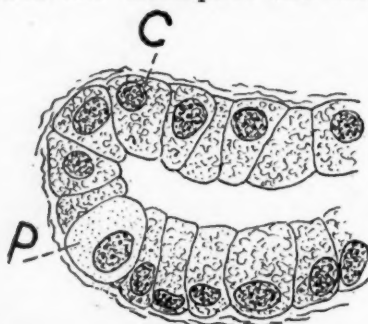


FIG. 10.—Regenerating gastric gland showing the formation of the parietal cells. From preparation shown in Fig. 9. C, chief cells; P, parietal cells.

as well as on the surface of the mucosa, karyokinetic figures indicate that the regenerative process is not yet complete. The cells of the gastric mucosa are all columnar in form, as parietal cells have not yet developed in the immediate neighborhood of the incision. At the point of junction of the two types of epithelium (Fig. 11, A), there are on both sides a few abnormally shaped cells. This condition is practically constant as long as the two forms of epithelium remain in contact.

SUMMARY

(1) The healing of gastro-enterostomies may, in parts of the anastomosis, take place by what we are accustomed to call "first intention," that is to say with a minimum of inflammatory reaction. This occurs when there has been only a slight interference with the circulation of the gastric and intestinal mucosæ. In these cases there is a prompt adhesion of the infolded serous surfaces of the two viscera by a slight fibrinoplastic exudate which also extends along the entire line of incision. The regeneration of the mucosa is well advanced in 24 hours and the defect in the mucosa may be covered

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in forty-eight or seventy-two hours. Nothing remains but the organization of the exudate to complete the healing. In such instances a portion of the anastomosis may be completely repaired in 5 or 14 days.

(2) The more usual and slower method of healing occurs when there has been more or less interference with the circulation of the

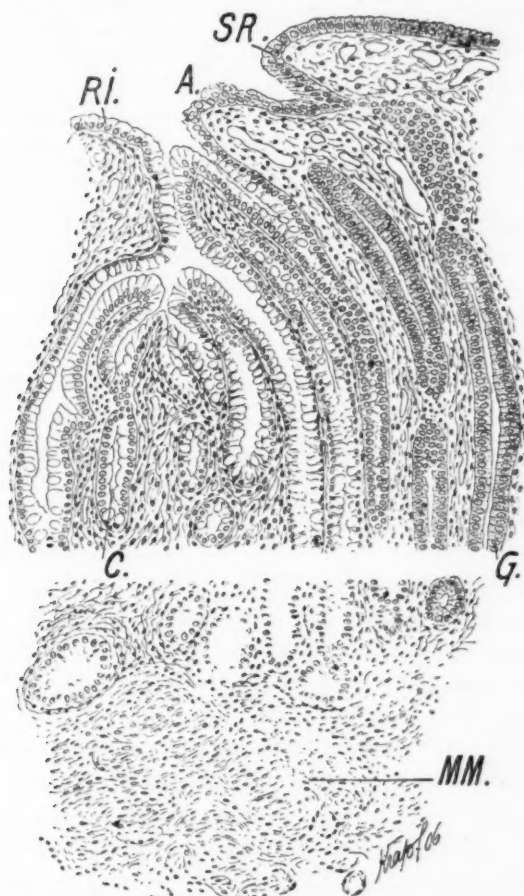


FIG. 11.—Meeting point of the gastric and intestinal epithelium in gastro-enterostomy fifty-five days old. *A*, abnormal cells at the point where the two types of epithelia meet; *RI*, regenerating intestinal epithelium; *SR*, regenerating gastric epithelium; *C*, crypt of Lieberkühn; *G*, young gastric gland; *MM*, new muscularis mucosae formed from the circular muscle of the stomach.

mucous membrane of the stomach and intestine. In these instances there is also an immediate union of the serous surfaces, which is accompanied by an exudate along the entire line of incision. A period of destruction now supervenes, involving those portions of the mucosa which have had their circulation injured or destroyed. This lasts from three to seven days, depending upon the extent of the injury. In the meantime the organization of the exudate has been progressing.

As soon as the destruction of the poorly nourished parts is complete, the period of restoration is inaugurated. This consists in repair of the injured mucosa and regeneration of the mucous membrane over the exudate forming the defect between the stomach and intestine. This is usually complete in 14 days. At the same time, the regeneration of the muscularis mucosæ and of the tunica muscularis is in progress.

(3) The regeneration of the intestinal mucosa takes place from the crypts which, in the neighborhood of the exudate, have returned to their embryonic form. From these crypts the epithelium flattens as it passes up on to the exudate, where it often penetrates its substance and forms a single layer of squamous cells. From this layer young crypts extend down into the organizing exudate and there produce new growing centres. The young villi appear as slight elevations from the general level of the mucosa and are gradually restored to their normal form. In the regenerative process the young crypts are, in the main, productive of the new elements, as nine-tenths of the karyokinetic figures occur in them. I have found, however, mitoses in the epithelium over the young villi, but they occur with relative rarity. After the restoration of the epithelium is complete the differentiation into the typical goblet cells and regular columnar cells takes place.

(4) The regeneration of the gastric mucosa generally begins from the less differentiated epithelium about the mouths of the gastric glands or from tubules that have returned to their embryonic form. As in the intestine, the new formed epithelium flattens as it passes up on the exudate, which it often penetrates as the extremity is reached. From this sheet of epithelium, new tubules are produced by invaginating into the substance of the exudate, which have the characters of embryonic glands. They are lined with an undifferentiated epithelium. As the preparation increases in age, cells appear in these young glands having a more or less strong acidophilic reaction to their cytoplasm. These increase in size and are finally pushed off to the side of the tubule and represent the young parietal cells. The remainder form the chief cells of the finished gland.

(5) The muscularis mucosæ begins to regenerate about the second week. It may be repaired from its cut ends or may be, in part, compensated for by means of muscle tissue derived from the severed ends of the tunica muscularis of either the intestine or the stomach. Tearing of this layer or failure of the layer to regenerate allows the crypts of the intestine to grow into the submucosa. At times these growths also occur at the site of the incision and penetrate for some distance into the submucosa and muscularis.

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(6) At times the tunica muscularis does not regenerate at all, the infolded muscular layers being held together by new formed connective tissue. In other instances there is considerable regeneration of the muscular layers. This seems to occur when the muscle bundles have been torn or the stitches are so placed that the pull of the muscle during the peristalsis tends to free some of the bundles, from the ends of which the regeneration can take place.

(7) After the gastro-enterostomy there is no modification of the intestinal epithelium. The cells appear perfectly normal. Furthermore, the intestine heals normally in the presence of the gastric juice. This may be due to the fact that the portion of the intestine between the lateral anastomosis and the opening of the stomach may produce enough succus entericus to neutralize the gastric juice in the neighborhood of the wound or more probably antiferments are present in sufficient quantities in the intestinal epithelium to prevent the digestion of this portion of the mucous membrane. Inasmuch as there is no tendency for the submucosal or muscular tunics to undergo digestion during the healing process, they are likewise undoubtedly supplied with antiferments against the gastric juice, although they are protected in a certain sense very shortly after the injury by the appearance of the exudate between the severed edges of the mucosa of the stomach and intestine.

(8) The clinical bearing of these studies emphasizes the fact that it is well for us to know not only the reaction of the stomach and intestine to the operative traumatism inflicted in performing a gastro-enterostomy but also the reparative process through which the organs pass during the period of healing. One should remember that the new formed anastomosis is the site of a healing ulcerated surface for a period of fourteen days and that, for the first five or seven days, the process is largely destructive, at least so far as the mucosa is concerned. Sight of this fact ought not to be lost in feeding these cases for the first two weeks, during which period the diet should be as light as is compatible with the maintenance of the strength of the patient.

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TRAUMATIC EXTRAPERITONEAL RUPTURE OF THE BLADDER WITH FRACTURE OF THE PELVIS

BY CHARLES E. HAWKES, M.D.

OF PROVIDENCE, R. I.

AN interesting article on this subject appeared in the July issue of *Surgery, Gynecology and Obstetrics*, by E. P. Quain, M.D. He collected from the literature and reported 127 cases, including 1 of his own. They were spread over a period of nearly a century. Of these, 32 were reported in this country, the remainder abroad.

He showed the total mortality to be 74 per cent. Of 83 cases reported before the year 1890, the mortality was 86.7 per cent. Of 44 cases subsequent to the year 1890, the mortality was 48 per cent. From 1905, out of 21 cases, 8 died, a mortality of 38 per cent.

To the above list of cases I wish to add one upon which I operated, October 24, 1915.

The history of the case is as follows: Mrs. W., thirty-three years old, was driving her touring car over a road that had been recently oiled. Her young four-year-old son sat beside her, on the front seat, while her mother, father and sister occupied the rear one. In attempting to steer out for an approaching machine, her car skidded to the right, and when the off-wheels struck the dry dirt, the momentum carried the car over on its right side. All were thrown clear of the machine except Mrs. W. The side of the tonneau came over on to the small of her back, pinning her face down to the ground.

Through the efforts of her father, in lifting up the side of the car, she managed to crawl from beneath. She did not collapse, for she has always proved herself strong and courageous in emergencies. Although badly hurt, she found she could move her legs, and could even stand, with assistance, but it hurt her considerably in the pubic and sacral regions. She was transferred to another automobile that came along and taken to her home in Providence. During this ride she had a frequent desire to urinate and passed small quantities of bloody fluid.

I attended her soon after she arrived home. Found her sitting on the edge of the bed in a good deal of distress. It hurt her to sit, stand, or try to move her legs. Her underclothes were stained with a bloody fluid. Her pulse was good. She suffered pain when assisted into bed. When quiet, she was at ease, but attempts to turn in bed hurt her.

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A fracture of the superior ramus of the left pubic bone was ascertained on palpation by crepitus. A catheter passed into her bladder withdrew from a half to one ounce of bloody urine. A diagnosis of ruptured bladder and fractured pelvis was made. A nurse was procured, and as no untoward abdominal symptoms were present, the patient was allowed to recover from the shock that had made its appearance.

She passed a little urine frequently during the night, which became less bloody. A catheter passed showed no urine left behind in the bladder. At ten o'clock in the morning her temperature was 99.5°, pulse 80. She had no nausea, no dullness in the flanks, no swelling in the groins, genitals or thighs. Her abdomen was becoming distended with gas and it was tympanitic all over, even over the liver region. She was very tender in the pelvic region externally, especially to her right of the median line.

An X-ray was taken of her pelvis by Dr. Hammond, which disclosed fractures of the superior and inferior rami of both pubic bones. This condition was produced by the crushing inward of the symphysis from the weight of the car on her back. The fragments of the fracture of the right superior ramus were somewhat displaced and a spicule or edge of one of the bones appeared as though it protruded somewhat inward and may have produced the wound in her bladder. The patient was conveyed to the Rhode Island Hospital in an ambulance and operated on at nine o'clock.

Operation.—Gas-oxygen with one ounce of ether was administered. A median incision was made from the symphysis to one inch below the umbilicus. The tissues in the region of the bladder were infiltrated with bloody urine, making it difficult to identify the peritoneum. The latter was opened, but no hole in the bladder was found on its posterior surface. Some bloody fluid deep in the pelvis may have leaked in through the peritoneal incision, or, more likely, resulted from the pelvic trauma. This was carefully mopped out and the intestines were walled off from the pelvis with gauze amputation rolls. A good deal of urine and blood was sponged out from in front of the bladder. By careful dissection and following the trail of the bloody fluid, a rent was finally found, deep down under the symphysis, and located on the anterior surface of the bladder. It was about an inch and a half long, the lower end reaching to the bladder-end of the urethra. A sound introduced into the bladder through the external meatus of the urethra served as an aid in identifying the structures and also in introducing the sutures. Two layers of the latter were used: the first to approximate the mucous coat, and the second, the serous coat. Chromic catgut was used. These sutures were taken with considerable difficulty, owing to the depth of the wound and

its location beneath the unyielding symphysis. No sharp spicule from the seat of the fractures was prominent enough to attract attention during the operation or demand correction. A cigarette drain was carried down to the wound in front of the bladder, and another behind the organ, in the peritoneal cavity. The abdominal wound was closed in layers around the wicks. Her pulse did not exceed 80 during the operation. The patient was put to bed and her pelvis swathed with a broad snug binder about her hips.

Subsequent Notes.—During the night she passed thirteen and one-half ounces of urine unaided and was catheterized at intervals to prevent bladder distention and cutting out of the sutures. Vomited once coming out of the effects of her anæsthetic. She was considerably distressed with gas on her stomach and was relieved by a turpentine enema, followed by small doses of calomel. The abdominal wound drained copiously requiring changes of dressings.

For the next two days the gas still distressed her a good deal. Eructations failed to relieve her, but enemas, saline laxatives and stomach washings gave her more comfort. During the afternoon of October 27, her temperature rose to 102.4° and pulse to 130. The cigarette drain behind the bladder was removed and a plain piece of rubber substituted. No bad odor was detected from the wound, which continued to drain satisfactorily, and no pus drained from it. Passed over seventeen ounces of urine herself, during the day, some also by catheter.

October 28: Less gas on stomach and more sleep last night than at any time since her operation. Temperature down to 99° and pulse 100. All drains were removed. Bowels moving freely and gas carried out by rectum. Distention of abdomen relieved. White blood count this afternoon was 14,400, polynucleated cells numbering 79 per cent., and the mononucleated 21 per cent. Temperature this evening 101° and pulse 105. Has had more restful day.

October 29: Began to menstruate yesterday. Sinus draining still and a strong odor is detected from it as though an infection from the colon bacillus were present. Smooth rubber drain inserted deep into sinus. No gas or fæces escaping from it. Distention of abdomen much diminished. Controls and voids urine very well. Temperature rose to 101° to-night again and pulse 105. No chill.

October 31: Sleeping better nights. Abdomen soft. Stomach distresses her but little now. Urine passed naturally in some quantity and also through sinus, odor being bad. Temperature 101° this afternoon.

November 2: No urine via urethra yesterday, so permanent

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catheter was inserted into bladder, giving constant drainage. Temperature 101.3° last night. Few sutures were removed from wound, next to sinus, to allow unimpeded drainage. Pus beginning to escape from it.

November 6: Temperature down to 98.6° this morning for first time. Catheter drains well part of the time and refuses to work at other times, even after being cleansed. All stitches removed to-day. Eating and sleeping well. Large piece of slough picked out of wound yesterday. Temperature 100.2° this evening. Feels bones of pelvis move at times, when her position is slightly changed.

November 10: Abdominal wound cleaner. Some pus in bladder, and irrigations of boric acid solution twice a day, started. Less urine draining from abdominal wound. Temperature below 100° nights now.

November 15: Abdominal wound healthy and fast closing in. Catheter drains well and cystitis improving.

November 20: Catheter gives considerable discomfort, so has been left out for two or three hour intervals for several days. Left out altogether to-night. Bladder irrigations continued, leaving in some solution of 15 per cent. argyrol.

November 25: Less urine from sinus. Very little pus in bladder. Temperature nearly normal nights. Crepitus in pelvic bones no longer palpated when she is moved.

December 1: Holds and voids urine at will. Can move her legs a little without aid. Scarcely any discharge from sinus.

December 5: Transferred to her home yesterday. Anticipation and excitement of this event caused return of urine flow through sinus. It has been noticed that emotions influence her bladder function very much. They cause contraction of the organ with very little flow of urine through urethra, and more through abdominal wound. Relaxation of mind causes reverse process.

December 10: Sinus dry for two days. No crepitus of pelvic bones elicited on palpation when thighs are flexed. Turns a little on side in bed herself.

December 22: Sinus has remained dry since last note. Moves legs well herself without pain. To sit up in bed, daily, after this date.

December 26: Sat up in chair with legs elevated in another chair yesterday. Sinus has closed. Fractures have united.

January 1, 1916: Up in wheel chair daily. Can cross legs without discomfort.

January 16, 1916: Getting around on crutches and experiences no pain in pelvis while bearing weight on feet. Has dispensed with her wheel chair. Little pulling sensation on abdominal wound

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when she straightens up. Wound has fully healed. No scab on it now.

February 25, 1916: Has used no crutch, cane, or any support for two weeks. Can walk up and down stairs. Gets up from chair and sits down without discomfort. Can stoop down and pick object from floor. Bladder gives her no trouble as to frequent desire to urinate or pain during the act. Has some backache latter part of the day yet from her exertions and tires easily. Sleeps well nights.

March 19, 1916: Took a ride in the electric cars to-day, it being her first day out of doors since her operation.

On October 6, 1916, I called on Mrs. W. at her home and found her feeling perfectly well. She complained of no urinary discomfort whatsoever. She walks as well as she ever did in her life, being free from all pain, limp, or any pelvic discomfort. Looks the picture of health. Has taken a number of rides in her machine, but has not ventured to drive it yet herself. Is very nervous when caught out on wet or slippery roads for fear of skidding. She has made a complete recovery from her very serious accident.

INDICATIONS FOR THE IODOFORM WAX BONE-FILLING OF MOSETIG-MOORHOF*

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OF PHILADELPHIA

SURGEON TO THE EPISCOPAL AND ORTHOPÆDIC HOSPITALS

IN 1903 Mosetig-Moorhof (*Zeit. f. Chir.*, 1903, xxx, 433) described his method of filling bone cavities with iodoform wax. His formula is: Iodoform, 60 parts; spermaceti and oil of sesame, each, 40 parts. These are to be mixed in a sterile pan, on a water-bath, being heated slowly up to 80° C., and the temperature of the mixture is then to be kept at 80° C. for fifteen minutes. The fluid mass is then removed from the water-bath, and is allowed to cool while being constantly agitated. This long continued agitation is extremely important in order to secure exact emulsification of the iodoform. Before being put to use, the solidified wax should be warmed up to 60° C., on a water-bath, being constantly stirred until thoroughly mixed.

Mosetig-Moorhof laid great stress on proper preparation of the bone cavity, emphasizing the necessity that it be not only sterile but also perfectly dry. The operation, of course, is done under Esmarch anæmia. Sterility is sought for, first by cutting away all unhealthy bone. This, as he says, often is a tedious job, and requires rather pedantic use of gouge, rongeur, etc. Then the cavity is irrigated with 1 per cent. formalin, or if there is the least oozing of blood into the cavity, hydrogen peroxide is employed. Next the cavity must be dried. Mosetig-Moorhof himself employed a hot air blast; but he said where this was not available cold air could be used if it was properly filtered and dried before being blown against the walls of the cavity. These walls were to be considered dry only when the glistening appearance of moisture was no longer present, as it was necessary for the wax to be applied intimately to the bony tissue, filling every crevice and even blocking the minute blood-vessels which were exposed in the walls of the cavity.

The wax, properly prepared by heating and thorough stirring, is now to be poured very slowly into the cavity until the latter is filled absolutely full. Pouring it in slowly he considered of the utmost importance in order to prevent the entrance of any air-bubbles. When the mass has solidified the soft parts are sutured without drainage,

* Read before the Philadelphia Academy of Surgery, December 4, 1916.

but not so tightly as to prevent the escape of exudations from the soft parts. Fistulæ and sinuses which are not included in the operative incision may be left as channels of exit for such necessary drainage.

Mosetig-Moorhof had operated on 120 cases by this method at the time of his original report; so that his method could no longer be considered in the experimental stage. In all these cases, he says, healing eventually occurred without fistulæ. In some cases, especially where the soft parts were in bad condition, a little of the wax exuded between the sutures; but the bulk of it remained in the cavity, and was slowly replaced by granulations from the surrounding bone.

Until the introduction of this method of treating bone cavities (resulting from operations for bone abscess, chronic osteomyelitis, necrosis, etc.), the only satisfactory way to secure their complete healing was to cut away all of the anterior and most of the lateral walls of such cavities, thus converting the former cavity into a shallow groove down and across which the soft parts could grow. This necessitated a very long time for complete healing of the wound, and in many cases recurrences took place because the surgeon had been too timid in removing overhanging bone at the original operation. Even when healing occurred, the scar resulting from the slow granulation of the wound was extensive, unsightly, depressed, and often so adherent to the underlying bone that slight injuries caused repeated disability.

Of course the iodoform wax filling is most easily applied and proves most satisfactory in cases of bone cavities which are sterile or nearly so at the time of operation. Thus, in cases of bone cysts (Case VI) or early and localized tuberculous disease (Case VII), primary healing usually may be expected; and even in cases of bone abscess with attenuated infection (Cases IX and X) healing usually will occur without further interference, though a sinus may persist for some months. But even in cases not as promising as those just mentioned, *Plombierung* is frequently of inestimable advantage. Thus in Case V and Case VIII, though a considerable portion of the wax was discharged during convalescence, the patients were spared the discomforts attendant upon frequent packing of the cavities with gauze; and in neither case was another operation requisite to secure permanent closure of the cavity. In Case V, moreover, a number of previous operations, in none of which was the iodoform wax employed, had been unsuccessful in obtaining cure of the disease. In Case VIII no previous operation had been done. In this connection, I think the course of events in Case I is of interest: here all the available wax (100 c.c.) was used in filling a cavity on the median side of the femur,

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and the opening on its lateral surface had to be packed with gauze. The result was that while the former wound healed without further interference, the outer wound required two subsequent sequestrotomies before permanent closure could be obtained.

One of the risks in using gauze in bone cavities is illustrated in Case II: though the surgeon who last operated upon this patient before she came under my care had filled the cavity with wax, it is evident that either then or at some previous or subsequent time a small fragment of gauze had been lost in the cavity, since I removed such a piece on reopening the unhealed cavity.

Case III was evidently an unsuitable one for treatment by bone wax. Amputation was clearly indicated, but was persistently refused by the patient and his family; death resulted from sepsis.

In Case IV (excision of the diaphysis of the fibula for osteomyelitis), while the wax probably was not necessary, yet I believe that it was useful in stimulating bony growth. At any rate, in a similar case in which no bone wax was used, the periosteal tube being allowed to fill with blood clot, complete regeneration of the bone did not occur, although a less extent of the fibula was removed (also subperiosteally) than in the case reported herewith.

In a number of cases, not recorded here, I have endeavored to sterilize the cavity by means of a hot air blast, as originally recommended by Mosetig-Moorhof. By employing the electric apparatus used for hot air douches (in the treatment of lumbago, etc.), and conducting the air into the cavity by means of a glass tube, I found the current of air could be delivered at a temperature of 100° C. But I found that this was not sufficient to sear the cavity, and I have been assured by bacteriologists that air could not be sterilized with certainty in so short a space of time as is required for its transit through this apparatus unless it were raised to a temperature of 300° C. Nor have I found radiant heat from the actual cautery more efficient. So of late I have abandoned any such methods, and content myself with chemical sterilization (phenol, iodine, alcohol) and mechanical drying.

The following case histories are selected as exemplifying the main indications for the use of the iodoform wax bone-filling.

CASE I.—Sequestrotomy for necrosis of femur. Alice McG., seventeen years of age, when first seen in 1908 had had several operations for chronic osteomyelitis of the left femur, but several sinuses remained above both the external and the internal condyles, through which bare bone could be felt; and from time to time there were more or less acute exacerbations due to pocket-

ing of pus. She was admitted to Dr. G. G. Davis's service at the Orthopædic Hospital, and operation was done May 14, 1908.

Operation (Dr. Ashhurst).—Under Esmarch anæmia three sequestra were removed from beneath an involucrum on the median side of the femur; the resulting cavity was filled with the iodoform bone wax (100 c.c.) and the soft parts were tightly sutured over it. The outer surface of the femur was exposed and curetted, and a button of bone was removed by a trephine, but as the bone appeared healthy here the marrow was not exposed. The outer incision was packed with iodoform gauze, as all the available wax had been consumed in filling the inner cavity.

The temperature rose to 102° F. on the day after operation, but gradually fell to normal. One month after operation the girl went home on crutches, there having been some discharge from both incisions.

July 14, 1908: Two months after operation she walked without a crutch, and the knee could be fully extended. This was impossible before operation. Both sinuses still discharged.

November 3, 1908: Scarcely any limp.

September 15, 1910: A sinus on the outer side persists, but there is no disability.

October 25, 1910: Inner sinus has again been moist for a few weeks.

June 1, 1911: Outer sinus has never entirely closed since last operation (iodoform gauze packing). The inner sinus has been closed for eight months, with exception noted in October, 1910 (bone-wax filling used on this side of femur). To-day carious bone was curetted above the external condyle; no sequestra were found. The wound was filled with iodoform bone wax and the soft parts were sutured tightly over it. A sinus formed here later.

November, 1911: Dr. Davis curetted and gouged the femur above the external condyle.

February, 1912: Several sequestra were spontaneously discharged from the remaining sinuses.

May, 1912: Scarcely any discharge, and only from sinus on outer side of femur.

June 14, 1916: The patient was examined again. The sinuses have remained healed since November, 1913. The knee flexes to 100 degrees and extends to 180 degrees. There is no disability, in spite of the marked thickening of the femur.

CASE II.—Bone abscess of tibia, removal of scrap of gauze from cavity. Elizabeth M., twenty-one years of age, was first seen in December, 1909, in Dr. Frazier's service at the Episcopal Hospital. It was a case of chronic osteomyelitis of the left tibia, of eight years' duration, for which fifteen distinct operations had

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been done. The last operation, in February, 1909, consisted in curettement and gouging of carious bone; the cavity had been filled with iodoform bone wax, but most of this had been discharged when the skin sutures were removed. Since this operation a small sinus and scab had persisted. For the last two months there had been worse pain, at times very severe. A skiagraph showed an involucrum in the upper third of the tibia, with apparently normal medulla above and below. Though a sequestrum was not visible, it was thought one must be present to account for the pain and persisting sinus.

Operation (December 17, 1909) (Dr. Ashhurst).—Esmarch anæmia. The old cicatrix and sinus were excised, and the periosteum reflected. When the cortex had been cut away, there was found not a sequestrum, but a bit of old gauze (Fig. 1), about half an inch square, which presumably had become lost in the cavity at a previous operation or dressing. The cavity in the bone was filled with iodoform bone wax and the soft parts tightly sutured.

January 15, 1910: The wax, which began to discharge when the sutures were removed, is still discharging.

January 20, 1910: Went home.

December 4, 1916: Patient reports that five or six subsequent operations have been done on her tibia, but that it has now been firmly healed for three years, though occasionally painful and tender.

CASE III.—Bone abscess of tibia. Andrew B., aged sixty-three years, was admitted to Dr. Frazier's service in the Episcopal Hospital September 9, 1911. Nine years before an abscess over the tibia had been opened by Dr. G. G. Davis under local anæsthesia. The incision soon healed and no further trouble had been experienced until about two weeks before his second admission, during which period there had been tenderness, redness and pain over the upper end of the right tibia. On admission the tibia was found thickened, with tenderness and redness and constant pain. The temperature varied from 101° to 103° F., and the leucocyte count was 10,720, with 88 per cent. polynuclears. The man was old for his years, feeble, and evidently seriously ill.

Operation (September 11, 1912) (Dr. Ashhurst).—Under Esmarch anæmia. Pus was found beneath the deep fascia. There was no cloaca on the subcutaneous surface of the tibia. The periosteum, which was thickened and did not strip easily, was reflected and the cortex removed. An abscess containing 10 to 15 c.c. of pus was found in the medulla. (Culture of this pus gave a growth of diplococcus. Histological examination of the bone showed osteomyelitis, with no evidence of tuberculosis.

Dr. C. Y. White.) The entire medulla and cortex throughout the upper third of the tibia (except extremely thin shell of cortex) was riddled with pus, and the bone was easily removed by Volkmann's sharp spoon. The knee-joint was opened at one point through a perforation in articular cartilage of tibia. The entire anterior wall of the cavity was cut away until apparently healthy bone was exposed in all places. No cloaca was found anywhere. The pus which was found beneath the deep fascia must have perforated the cortex through one of Volkmann's canals. The cavity was swabbed with very hot carbolic acid (pure phenol), and then flooded with alcohol, and finally dried with gauze. The cavity was filled with iodoform bone wax, requiring 120 to 150 c.c. The soft parts were closed as securely as possible. It was noted that amputation probably would be required.

The patient did badly, became delirious at night, and six days after operation the knee-joint was found swollen and painful, with much pus discharging from the wound. The patient and his family repeatedly refused amputation, and death occurred September 30, three weeks after operation, from sepsis.

CASE IV.—Excision of diaphysis of fibula for osteomyelitis. Rose H., twelve years of age, was first seen in Dr. Davis's service at the Orthopædic Hospital in May, 1912. In October, 1911, the girl had fallen over a rope and hurt her right leg. It swelled up, and in November, 1911, two incisions were made by the family physician under a general anæsthetic, and the wounds were packed with gauze for a long time subsequently. When seen at the Orthopædic Hospital the whole outer side of the right calf was bluish, the skin thickened and hard; two sinuses were discharging pus: one, above the middle of the fibula, the other just above the external malleolus. A skiagraph showed the fibula thickened to the size of the tibia, and at the upper sinus a sequestrum projecting from the cortex. There was no evidence of recently formed subperiosteal bone, nor of a marrow cavity, nor of an internal (tubular) sequestrum.

Operation (May 10, 1912) (Dr. Ashhurst).—Under Esmarch anæmia the entire diaphysis of the fibula was removed by twisting out each end, after sawing through its centre. Numerous small areas of subperiosteal bone were left attached to the periosteal tube. After suturing the periosteum, deep fascia and skin, except over the centre of the incision, the periosteal tube was injected with iodoform wax. The centre of the incision was then closed tightly, the wound dressed, and the Esmarch band removed. A plaster-of-Paris dressing was then applied from toes to upper thigh.

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May 12: Temperature 102° F. No symptoms. X-ray shows wax only in central portions of periosteal tube.

May 15: Temperature normal since May 12. First dressing through window in gypsum case. Moderate purulent discharge from two ends of incision.

July 23, 1912: Has been walking without support for three weeks. Incision firmly healed for one week. Skiagraph shows nearly complete regeneration of fibula.

March 11, 1913: Skiagraph shows complete regeneration of fibula, 10 months after operation.

March 23, 1914: Presented at a clinical meeting of the Philadelphia Academy of Surgery, held at the Episcopal Hospital.

CASE V.—Recurrent osteomyelitis of tibia. Philip R., sixteen years of age, was seen in Dr. Frazier's service at the Episcopal Hospital, in December, 1912. In April, 1912, the right knee became painful and tender following a slight injury, and after being at home a few days in bed he was admitted to Dr. Mutschler's service in the Episcopal Hospital, April 9, 1912. Two days later Dr. Mutschler made an incision through the periosteum of the tibia, finding subperiosteal pus. The cortex was not incised. The boy did not do well, and on June 28, Dr. Mutschler operated again, finding new-formed subperiosteal bone; this time the medulla was opened and drained. In October, 1912, and again in November, 1912, Dr. Frazier removed some necrotic bone.

December 10, 1912: For the last few days there has been tenderness and redness and pain around the head of the tibia, this being a part of the bone not explored at any of the former operations. There are now gutters in the upper and lower thirds of the leg, with an area nearly healed in at the middle third. The foot is in slight permanent equinus. The boy is thin, pale and anæmic.

Operation (December 11, 1912) (Dr. Ashhurst).—Esmarch anæmia. The cicatrix in the upper third of the tibia was excised, and the head of the bone was exposed. Little periosteum was left; the cortex was gray, spongy and soft, and infiltrated with pus. There was an abscess in the medulla extending up to the epiphysial cartilage. The cavity was swabbed with pure carbolic acid, flooded with alcohol, dried, and filled with iodoform bone wax (50 to 75 c.c.) (Fig. 2). By undermining the skin this could be sutured tightly over the wax. The leg was dressed on an inclined plane in a fracture box.

December 15, 1912: There has been no rise in temperature nor any unfavorable symptom since operation. Subsequently, when the sutures were removed, some of the wax discharged through the opening.

March, 1913: There remains an opening three inches long and one inch deep at the upper end of the tibia; this is covered with healthy granulations.

June, 1913: Granulating area at upper end of tibia, 2 cm. deep.

September, 1913: Upper area of granulations only 5 cm. long and shallow. In lower part of leg only a superficial ulcer remains. Gradual healing after this date.

November 22, 1915: Reports now because of painful swelling over *left* tibia. The right leg is not yet completely healed, as the scar is thin and adherent to the bone, and easily breaks down.

November 23, 1915: The swelling over the left tibia was exposed under Esmarch anæmia: the periosteum was thickened and was partly responsible for the spindle-shaped swelling. The cortex, which was removed by gouge, was very thick and sclerosed. The medulla when exposed was apparently normal. The overlying cortex was removed for a distance of about 10 cm. (A culture from the medulla remained sterile. The bone specimens were lost in the laboratory.) The cavity was filled with iodoform bone wax, and the soft parts were sutured tightly. Then the adherent cicatrix was excised from the right tibia, and the skin closed without tension by undermining its edges.

December 9, 1915: The boy was allowed to go home. There had been a slight oozing of wax from the incision in the left leg. The right leg was healing well.

November, 1916: The boy was seen on the street several months after leaving the hospital, and appeared to have no disability. As he has not returned for further dressings, it is presumed the incisions have given no further trouble.

CASE VI.—Bone cyst of tibia. Columbia G., five years of age, for two or three years had had swelling above the left ankle. For the last four or five months there had been pain and a limp. She was admitted to Dr. Frazier's service in the Episcopal Hospital. Skiagraphs showed a cyst in the lower end of the tibia. (Figs. 3 and 4.)

Operation (August 27, 1913) (Dr. Ashhurst).—Under Esmarch anæmia a curved incision was made over the subcutaneous surface of the lower end of the tibia. The periosteum was a little thickened, and the cortex slightly hyperæmic. The cortex was about 2 mm. thick, and on removing this a yellowish-white cyst wall bulged into the opening. On cutting through this with scissors, some semifluid matter, which resembled tuberculous pus, oozed out, and then considerable cheesy matter, but no fluid. There was a good deal of carious spongy red bone surrounding the cavity, and it was thought to be a tuberculous abscess of bone. On the posterior wall of the cavity the cyst had perforated the

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cortex over an area about 3 mm. in diameter. The cyst cavity was the size of a pigeon's egg, and extended down to the epiphysial cartilage. The cavity was scraped clean, and filled with bone wax (Fig. 5). The soft parts were closed without drainage, and a plaster-of-Paris dressing was applied.

September 3: Gypsum dressing removed, on account of pain in the leg. A little of the wax was found discharging between two sutures. A new gypsum case was applied, with a window over the wound.

October 3: No discharge from the wound since last note. Wound now healed.

November 28: Sent home, walking, in light brace. A skiagraph (Fig. 6) showed considerable concentric growth of bone around the iodoform wax filling, which has been slightly absorbed.

February 12, 1914: Six months after operation. The leg seems normal. The foot does not dorsiflex beyond 90 degrees. She continues to wear the brace. Circumference of right calf, 21.5 cm.; of left calf 18.5 cm.

November, 1916: A report from this patient was secured through the Social Service Department of the Orthopædic Hospital. There is no apparent disability, and the wound continues closed.

Pathological Report (Dr. C. Y. White).—Culture and smear from cyst negative. Unfortunately the cyst wall and contents were mislaid in the operating room, and did not reach the laboratory in fit condition for histological study or for inoculation into guinea-pigs.

CASE VII.—Tuberculous cyst of ulna. James C., when about six years old, fell and hurt his left elbow. He seems to have suffered no particular disability as a result, but two years later (July, 1914) applied to the Orthopædic Dispensary of the Episcopal Hospital for limitation of motion. There was decided limitation of rotation in the forearm, and the elbow flexed only to 50 degrees and extended to 130 degrees. There was no pain, no heat, and only slight thickening of the elbow region. A skiagraph showed a cystic condition of the upper end of the ulna, apparently extending to the joint surface (Figs. 7 and 8). It was thought to be a "benign bone cyst," and, after keeping the child under observation for four months, and finding no change in the local condition, operation was advised and accepted by the parents.

Operation (November 4, 1914) (Dr. Ashhurst).—Under Es-march anæmia an incision was made over the subcutaneous surface of the ulna below the olecranon. The periosteum was incised and reflected. The cortex appeared unduly inflammatory, with a large number of bleeding points (much as the tibia in Case VI); the

cortex was soft and easily removed by a gouge, without the use of a hammer. The cortex was 0.5 cm. thick, and when it was removed a smooth fibrous layer was exposed, which constituted the cyst wall. Enough of the overlying cortex was removed to expose the cyst wall fairly well, over an area approximately 2 by 4.5 cm. An attempt was then made to enucleate the cyst without rupture, but this proved impossible, since at the coronoid process of the ulna and over the entire articular surface the cyst wall was densely adherent to the bone, dipping down into irregular notches and depressions. Those portions of the cyst wall which were not removed along with the cyst contents were scraped off the adjacent bone with the sharp spoon. The contents of the cyst resembled granulation tissue; no fluid was present. The cavity in the ulna was filled with iodoform bone wax (Fig. 9) and the periosteum and then the skin tightly sutured. The Esmarch band was not removed until after the dressings had been applied. The pathological study of the specimen (Dr. C. Y. White) showed tuberculous osteomyelitis; injection of the tissue into a guinea-pig was positive for tuberculosis. This report is of interest, especially as the X-ray picture did not suggest a tuberculous process. The skiagraph is practically identical with that of the second case reported as chronic fibrocystic osteomyelitis by Barrie (*Surgery, Gynecology and Obstetrics*, 1914, xix, 42, Fig. 2).

November 23, 1914: There has been a little discharge of wax since operation.

December 7, 1914: Wound is firmly healed.

December 18, 1914: Plaster-of-Paris case applied, the laboratory report of the tuberculous nature of the lesion having been received.

March, 1915: Gypsum case removed, and arm carried in a sling.

May, 1915: As heat in elbow persists, an internal angular splint was applied, in addition to the sling.

June, 1915: No heat or swelling. Splint removed.

July, 1915: Sling discontinued.

October, 1915: Motion 50 degrees to 120 degrees. Never any pain.

August, 1916: Motion 70 degrees to 140 degrees. No symptoms.

November, 1916: Motion 45 degrees to 115 degrees. Plays ball and has no disability. If motion does not improve when epiphysial growth is complete, excision of the elbow may be advisable. A skiagraph shows no vestige of wax remaining; the upper end of the ulna is rarefied, but much of the cortex has reformed, apparently of normal density.

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CASE VIII.—Necrosis of radius. Joseph P., nine years of age, September, 1915, came to the Orthopædic Hospital with running sores in his left forearm. The trouble began acutely about one year previously, with pain, swelling, and disability in the left forearm, the height of the attack being reached within one day of its onset. He was in a hospital for seventeen days, but no operation was done. Two months later sinuses formed, and later still his family physician made an incision over the head of the radius. This is the only opening that has healed. Three sinuses are still open: one above the internal condyle of the left humerus, one below the flexure of the elbow, and one above the styloid process of the radius. The discharge is profuse and very foul; and the radius is thickened. Supination is lost, and there are only 30 degrees of motion in the elbow. A skiagraph shows a long sequestrum present beneath an involucrum of the radius, in which two cloacæ are visible. The epiphysis of the head of the radius is displaced in front of the elbow-joint, but the remainder of the radius is not dislocated (Fig. 10).

Operation (September 11, 1915) (Dr. Ashhurst).—Esmarch anæmia. Incision upward from radial styloid, excising the lowest sinus. The superficial radial nerve was identified, and followed up to the interval between the brachioradialis and the extensor carpi radialis longior, thus baring the shaft of the radius to above the attachment of the pronator teres. The involucrum was 2 cm. thick, and the two cloacæ seen in the skiagraph corresponded to the two sinuses in the soft parts. Through these the long sequestrum was visible. The involucrum was cut away from one cloaca to the other, a distance of 12 cm., and the sequestrum was removed (Fig. 11). It was a cortical sequestrum, evidently part of the original cortex, the involucrum being formed by new subperiosteal bone. Exploration of the sinus above the internal condyle showed that it led to the region of the head of the radius. A second incision was made, therefore, over the head of the radius, and the radius bared, and a tunnel made directly through its head, in the search for another sequestrum. None was found, but on introducing a curette into the sinus above the internal condyle a moderate amount of pus was evacuated, and the epiphysis of the radial head was found lying loose in the sinus as a sequestrum (Fig. 11). The bone cavities were dried by radiations from the Paquelin cautery, filled with iodoform bone wax, and the soft parts tightly sutured, except the old sinus above the internal condyle.

September 18: The incisions have broken open, but there has not been much discharge of pus or wax (Fig. 12).

September 27: Most of the wax seems to have been discharged, and the incisions are closing in.

February, 1916: The boy has been at a convalescent home since the autumn. The incisions are all healed; only a scab remains over the head of the radius, and in the centre of the long incision over the lower radius. There is motion in the elbow from 80 degrees to 120 degrees; the forearm is in almost complete pronation, and little rotation is possible. An abscess in the axilla has recently formed and has been opened, leaving a mass of lymph-nodes, which were excised in March, 1916.

November, 1916: All sinuses remain closed. Range of motion a little greater.

CASE IX.—Bone abscess of tibia (Markoe's abscess).¹ Harriet C., thirty-nine years of age, had had disease of her right tibia ever since she was fifteen years old. For twenty-four years a sinus had persisted over the upper end of the crest of the tibia, where the bone was thickened (Figs. 13 and 14). She was admitted to the Episcopal Hospital.

Operation (November 9, 1915) (Dr. Ashhurst).—Esmarch anæmia. The sinus in the soft parts was excised, and the bone overlying the abscess cavity was removed by gouging. The cavity contained reddish-brown granulation tissue. Pathological examination of this tissue gave a "mixed growth" and there was no histological evidence of tuberculosis (Dr. C. Y. White). No normal medullary cavity was exposed, the bone surrounding the abscess cavity on all sides being inflammatory, and resembling in appearance that seen in cases of staphylococcic inflammation. The cavity was filled with bone wax, and the soft parts tightly sutured over the bone. The Esmarch was removed after the limb had been dressed.

November 24, 1915: Upper portion of incision has healed solidly, but some wax exudes below.

December 8, 1915: Went home, using crutches. A small sinus remains, which is barely moist.

November 8, 1916: Reports for examination one year after operation. The incision has been firmly healed since June (five months). There is no disability.

CASE X.—Bone abscess of tibia (Markoe's abscess). Eugene S., thirteen years of age, cut his left leg by a knife, in May, 1915, injuring the bone below the knee. He came to the Episcopal Hospital in December, 1915. In July he had begun to complain of pain in this region, and after three weeks of increasing dis-

¹ "Markoe's abscess," described by Thomas M. Markoe of New York, in his "Treatise on Diseases of the Bones" (1872), as "*chronic sinuous abscess of bone*."



FIG. 1.—Case II. Fragment of gauze (from previous operation) removed December 19, 1909, by sequestrotomy.



FIG. 2.—Case V. Iodoform bone wax in cavity of tibia, one week after operation.



FIG. 3.—Case VI. Bone cyst of tibia.



FIG. 4.—Case VI. Bone cyst of tibia.

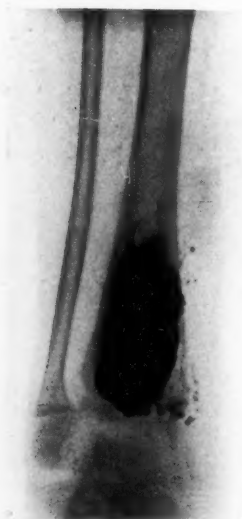


FIG. 5.—Case VI. Cavity in tibia filled with wax, a few days after operation.



FIG. 6.—Case VI. Eleven weeks after operation, showing partial absorption of bone wax filling.

FIG. 7.

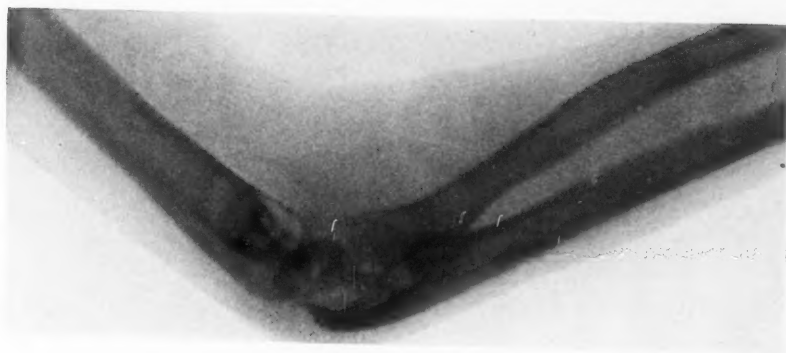
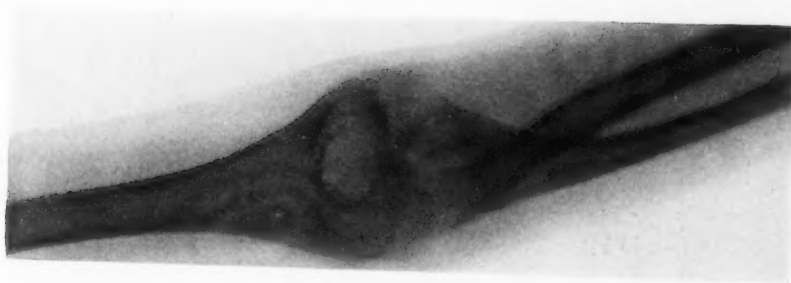


FIG. 8.



FIGS. 7 and 8.—Case VII. Tuberculous cyst of ulna, two years after injury.



FIG. 9.—Case VII. Iodoform bone wax in cavity of ulna, a few days after operation.



FIG. 10.—Case VIII. Necrosis of radius, one year after onset. Cortical sequestrum in shaft of radius surrounded by involucrum; also epiphysis of head of radius detached as sequestrum.

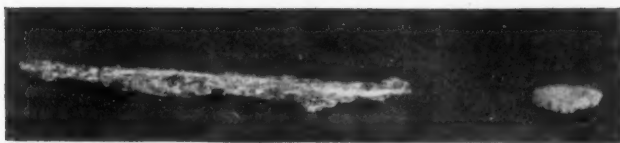


FIG. 11.—Case VIII. Sequestra from radius. Small one is epiphysial centre of head of radius. Large one is cortical sequestrum from shaft (embedded in new subperiosteal bone).



FIG. 12.—Case VIII. One week after sequestrotomy and *Plombierung*.

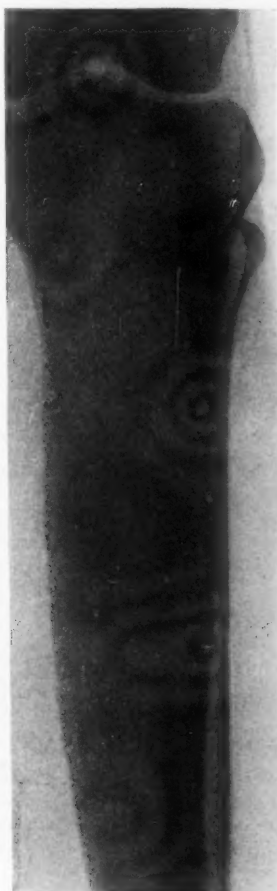


FIG. 13.—Case IX. Chronic sinuous abscess of tibia for twenty-four years (Markoe's abscess).

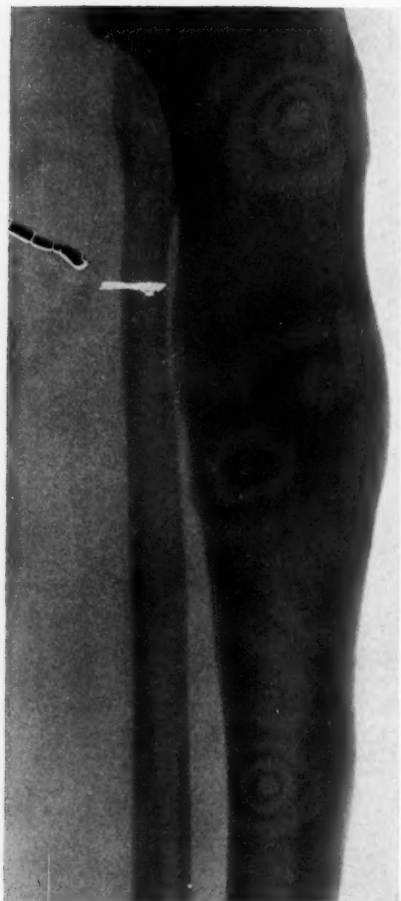


FIG. 14.—Case IX. Markoe's abscess of tibia (chronic sinuous abscess), discharging for twenty-four years.



FIG. 15.—Case X. Bone abscess, eleven days after operation.

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ability an abscess had been lanced, in August, 1915. Since then a sinus had been present over the head of the tibia, at times scabbed, but usually weeping a little thin pus. Small pieces of bone had been discharged occasionally. A skiagraph showed a cavity in the upper end of the tibia.

Operation (December 8, 1915) (Dr. Ashhurst).—Esmarch anæmia. A flap of skin was turned up from the head of the tibia, with its base on the fibular side. The sinus led into the tibia just below its tubercle on the median side of the bone. The overlying bone was removed by gouge, and the abscess cavity exposed. This was found to extend through the cortex posteriorly over a small area, where the abscess cavity was limited by periosteum. The tibial crest was not removed, but by gouging away the lateral as well as median surfaces of the tibia, the abscess cavity was fairly well exposed. The surrounding bone, infiltrated with puriform matter, was scraped away by Volkmann's spoon until healthy hard bone was reached on all sides, and until healthy red marrow was exposed below. The cavity was then filled with 3 per cent. iodine solution, and when this was wiped out it was replaced with iodoform bone wax, about 30 c.c. being required. The periosteum and skin were closed separately over the wax, as securely as possible. After dressing the wound the Esmarch was removed.

The pathological report on the tissues (Dr. C. Y. White): Chronic granulation tissue; guinea-pig injected remained negative for tuberculosis. Smear from pus showed a large diplococcus.

December 19: A skiagraph shows the wax filling the cavity (Fig. 15).

January 22, 1916: Went home, incision almost dry.

February 21, 1916: A skiagraph shows the wax all gone: most of it has been absorbed, as no recognizable quantities have been discharged.

November 8, 1916: A small sinus remained moist until last June. Since then it has been open only one day. The incision is now firmly healed.

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting, held December 4, 1916

The President, DR. CHARLES H. FRAZIER, in the Chair

SUBPERITONEAL HEMORRHAGE, RESULT OF PURPURA
HÆMORRHAGICA SIMULATING APPENDICITIS

DR. I. M. BOYKIN reported the history of a boy, aged six years, who was admitted to the Episcopal Hospital August 21, 1916, supposedly suffering from an appendiceal abscess. His previous general health had been good up to three days before admission, when he began to complain of severe pain in the abdomen, with vomiting. The child was kept in bed until the third day, when the family physician made the diagnosis of appendicitis and on his recommendation the child was brought to the hospital.

After admission he lay in bed with his right thigh acutely flexed on the abdomen and the member could not be extended without agonizing pain. There was a decided pallor. Just above Poupart's ligament on the right side was a mass, well defined and tender. There was slight rigidity of the right side of the abdomen, the left side seemed normal. In the left anterior tibial region were two ecchymotic spots about the size of a dime, which were presumed to be bruises.

Reflexes normal. Temperature 101°, pulse 100, respirations 28, leucocytes 14,000. The history and the data elicited by examination were in favor of an appendiceal abscess.

The child was taken directly to the operating room and under ether anæsthesia an incision made over the top of the mass. The blood that flowed into the skin incision was very dark. The abdominal muscles were almost black. The peritoneum was opened and the appendix presented in the wound, apparently normal. The peritoneal fluid was in excess and slightly blood tinged. The mass, which was felt through the abdominal wall, was found to be retroperitoneal and to consist of a blood clot. The patient's condition would not permit further investigation, so a cigarette drain was inserted and the abdomen closed. The patient died the same evening without reacting.

Several hours before death it was noticed that, in addition to the two ecchymotic spots on the left tibia, there were many others on the

AVULSION OF LESSER TROCHANTER OF FEMUR

lower extremities and also on the abdomen in the region of the wound.

A postmortem could not be obtained, but the wound was reopened and enlarged. Unsatisfactory as it was, the following important points were noted: Wherever the intestines were touched at time of operation there were ecchymotic spots, almost corresponding to finger prints. There was a retroperitoneal blood clot, extending from Poupart's ligament to the upper pole of the right kidney. The peritoneum was adherent to clot at a point corresponding to that of the patient's pain. The clot was removed and the ruptured vessel looked for but none was found. Both kidneys were taken out and incised. In the cortex and medullary portions of both were found small hemorrhages; a blood clot was found in the pelvis of both.

AVULSION OF THE LESSER TROCHANTER OF THE FEMUR (EPIPHYSIAL SEPARATION)

DR. GEORGE G. ROSS related the history of a boy, fifteen years of age, who, on June 24, 1916, while playing baseball, received an injury to his upper right thigh. He struck a ball and started to run for first base; after the third stride he fell to the ground. The pain, which was in the right groin, was severe and prevented walking, as attempts at flexion of the thigh on the body markedly increased the pain. He could stand with fair comfort and was relieved when the limb was in flexion and adduction. On attempting movement he said it felt as though there was a marble in his groin. Passive motion did not cause pain. There was tenderness on deep pressure both over Scarpa's triangle and on the posterior surface of the thigh. There was no ecchymosis or swelling. Dr. Kelly, of the Germantown Hospital, who brought him to the hospital, found him lying on his left side with the right thigh semiflexed and adducted.

One year prior to the present accident, the patient was butted in the right groin by another boy's head, causing him to fall backward. He had severe pain in the right groin which he said felt like a muscle bruise. He limped for a week and felt a grating sensation for some months and was unable to take exercise due to soreness and inability to lift the thigh. Pain was relieved by recumbency. Later he was able to take exercise and felt no discomfort. He said that the day before his second accident he felt some soreness in the groin with some interference with flexion.

The patient had had measles, chicken-pox, mumps, pertussis, but never had tonsillitis. His family history was negative, except for one uncle who has tuberculosis, but this uncle does not live in the same house with the patient.

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Dr. Kelly made a diagnosis of tearing of the iliopsoas muscle attachment. X-ray picture showed a separation of the lesser trochanter of the right femur without other fracture.

From the history of this case it is difficult to say whether the separation of the lesser trochanter occurred at the primary traumatism of a year ago from direct violence or at the second accident when the exciting force was applied by the pull of the iliopsoas muscle. It seems probable that the injury followed the first trauma and recurred at the second injury.

The condition was met by placing the limb in a plaster case in a position of semiflexion and extreme adduction. This at once relieved his pain. After three weeks the case was removed and the patient given massage and passive motion. At the present writing the patient uses the limb without discomfort or any limitation of function.

HUTCHINSON (*British Med. Jour.*, December 30, 1893, p. 671) reports a case of Fenwick's in a boy of seventeen, who leaped from a fence and fell backward, breaking off the lesser trochanter, apparently by the pull of the psoas iliacus. This was verified by incision. The patient died of septicæmia on the seventeenth day.

JULLIARD (*Progrès Méd.*, 1879, vii, p. 825) reports a case of a man, eighty-two years of age, who was injured by falling as he rose from bed. He suffered from marked pain, eversion, and disability until death. The autopsy showed a large extravasation of blood in the muscles. The joint and neck of the femur were intact and the lesser trochanter was broken off and adherent only by a strip of periosteum. There was, however, a small area at the upper extremity of the femur which showed sarcomatous degeneration.

ASHHURST (*Surgery, Its Principle and Practice*, 1914, p. 368) mentions eight cases, collected by Binet and Hamant (1911), of isolated fracture of the lesser trochanter, and says that isolated fracture of the great trochanter occurs and may require periosteal suture to maintain reduction.

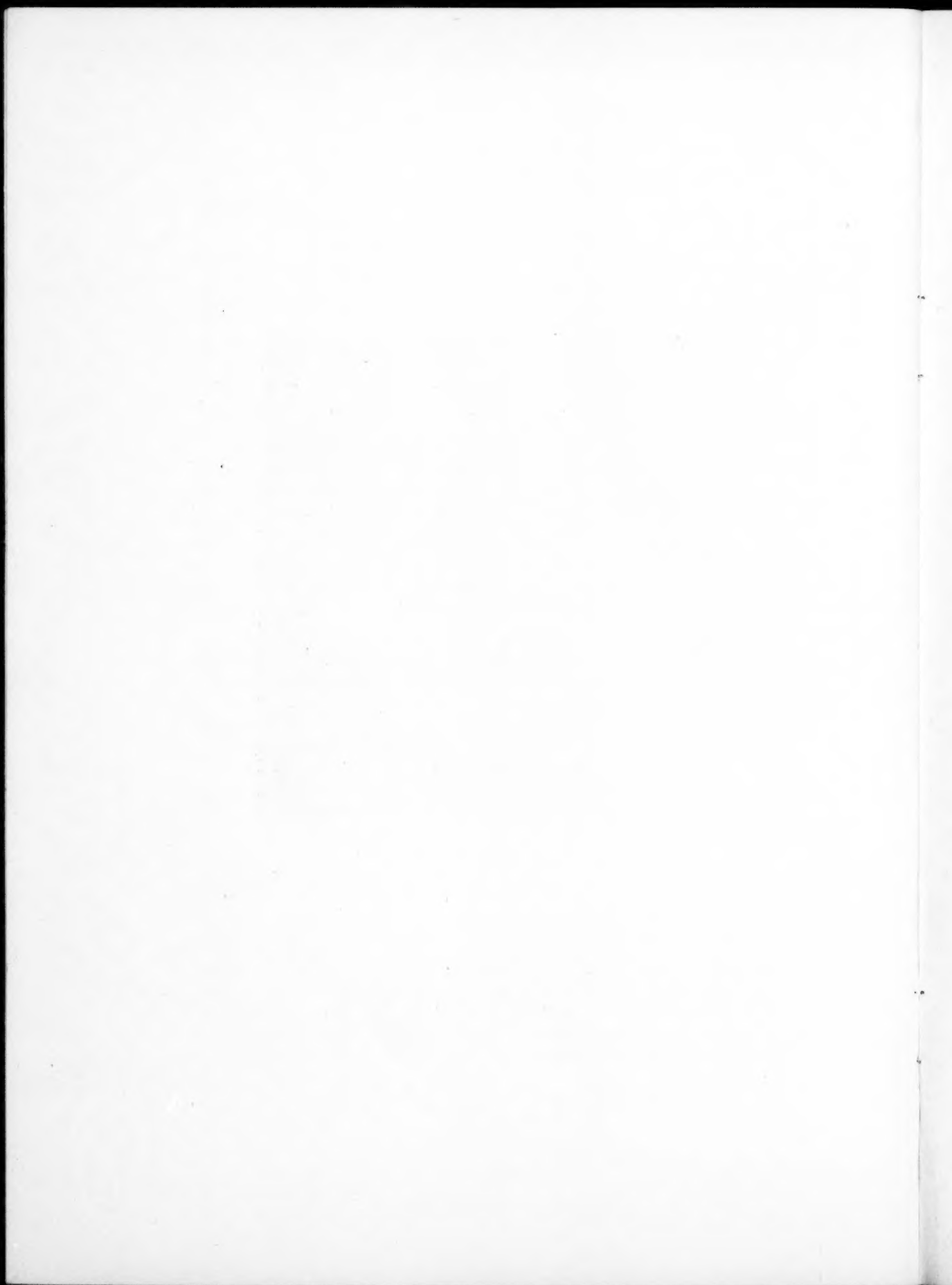
METCALF (*Jour. of Amer. Med. Asso.*, 1915, lxiv, 1234) collected fifteen cases since 1854. This list includes the eight cases collected by Binet and Hamant in 1911. Metcalf does not include the case of Fenwick's reported by Hutchinson as mentioned above. This would make the total sixteen up to 1914. Metcalf reports two cases from his personal experience. This brings the total up to eighteen cases to 1914. Since that time I have been unable to find any reports of such cases and my own case would bring the total up to nineteen.

Fracture of the lesser trochanter complicating other injuries to the femur is not an uncommon occurrence. Ashhurst (*ANNALS OF SURGERY*, 1913, lviii, 494) mentions six cases admitted to the Episcopal Hospital, Philadelphia, during six months with fracture of the lesser trochanter complicating fracture through the trochanter.

Metcalf's first case in a patient seventeen years of age was due to a bump from a fellow player, causing the right limb to slip suddenly backward. His second case was in a boy of sixteen years, who while running in a football game wheeled quickly to the right to catch a



FIG. 1.—Avulsion of lesser trochanter of the femur.



AVULSION OF LESSER TROCHANTER OF FEMUR

forward pass and as he did so his left limb dragged behind in extension and he fell to the ground.

Metcalf gives four symptoms: Pain, slight when quiescent, increased on walking and flexing thigh; other motions little or no effect on pain; tenderness on direct pressure over the lesser trochanter.

In this case flexion was impossible beyond one or two inches. Voluntary flexion caused intense pain. Passive motion did not cause any discomfort. Pain was elicited on pressure over the lesser trochanter, both on the anterior and posterior surface of the thigh.

Loss of function, either partial or complete. Some of the cases were able to walk but stiff-hipped and with discomfort. Loss of function was the observation in most of the cases, although Brunelli's case continued his occupation for a week after the accident. Deformity—Eversion was noted in adults. Chaput's case, aged fifty-two, held his leg in external rotation flexion and abduction. Gray noted external rotation which could, however, be readily overcome. In young persons there seems to be no reported deformity. There certainly was not in this case. The limb was held in adduction and semiflexion to relieve the pain; this was postural and not deformity. In old people there is reported ecchymosis and swelling; here again differing from the younger patient. In Metcalf's cases these signs were absent, as they were in this case. The diagnosis rests therefore on a history of trauma in which the applied force is directed through the iliopsoas muscle to the lesser trochanter and localized pain and tenderness in the groin. Inability to flex the thigh or if flexion is possible it is according to Ludloff's sign. With the patient on the back he can lift his thigh by using the rectus femoris, but is unable to flex the thigh while in a sitting position. Localized swelling and pain may be present or absent according to the age or youth of the patient.

Treatment should be non-operative. As one cannot bring the small fragment down to its normal position on the femur, bring the femur up to meet the fragment and retain in a fixed dressing in semiflexion and adduction.

DR. JOHN H. JOPSON added the history of a boy of sixteen years, whom he saw in consultation with Dr. Girvin, January 9, 1915. On November 10, 1914, while playing football and running after a forward pass, the boy turned to the right and fell with the thighs flexed. He experienced slight pain and a sensation of something giving way in the upper inner region of the thigh, sensation being described by him as similar to that of "putting elbow out." Immediately after the accident he could not use the knee well, but was able to walk home. In the evening, while walking, pain became very severe and interfered with

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flexion of the thigh. Dr. Metcalf, physician to the school, had an X-ray taken on the following day which showed apparently partial detachment of the epiphysis of the lesser trochanter. The leg was most comfortable when kept slightly flexed. He was treated with a plaster case for nearly three weeks. There was no localized tenderness or swelling. After the plaster case was removed a leather splint was applied which embraced the thigh and pelvis. When seen January 9, 1915, he had been walking with the splint but without crutches since December 21, 1914. Examination at this time showed nothing except slight atrophy of the thigh muscles. X-ray was taken by Newcomet, which confirmed diagnosis of fracture or avulsion of the lesser trochanter of the femur.

Patient states that a similar case occurred in the same school within a year or two, the boy being injured while playing hockey. This patient also was able to walk around for a few hours after the accident.

DR. HENRY R. WHARTON said that some years ago, before the days of the X-ray, he had a patient admitted to the Children's Hospital, of about ten years of age, who had fallen downstairs and struck at the foot of the stairs with violent separation of the thighs. There was great tenderness on the anterior of the thigh and of the pelvis posteriorly. He imagined there was a muscular lesion. A few days later there was high temperature and an abscess developed in the right groin which was incised. There was found to be separation of the epiphysis of the lesser trochanter. The patient finally made a recovery. Looking up the literature at the time he found the condition to be comparatively rare, and that septic infection was not uncommon.

DR. P. G. SKILLERN, JR., remarked that owing to the low, sessile nature of the lesser trochanter, actual fracture of this process in the adult must be much rarer than its disjunction as an epiphysis during the period of adolescence, or between the ages of eight and nineteen years, the epiphysis appearing at about the eighth year and uniting with the shaft at the nineteenth year. A case has been recorded in which this epiphysis was torn off in a boy of fourteen, as the result of the strain on the iliopsoas in a fall backward on the feet. Death from pyæmia followed. The majority of cases occur in this epiphysial age. Roberts and Kelly cite three cases which occurred in men beyond middle life, in which the injury was due to muscular pull in falling. In one case the patient was run over by an omnibus. The injury is due to the pull of the iliopsoas muscle.

Dr. Ross stated that he dressed the limb in the position of flexion with adduction. It is surprising how much tension may be taken off of the lesser trochanter and relaxation obtained by the manœuvre of

INDICATIONS FOR MOSETIG-MOORHOF BONE-FILLING

external rotation of the limb. This brings the lesser trochanter well forward, and it should be added to Dr. Ross's flexion with adduction, superlative relaxation thus being obtained by flexion, adduction, and external rotation of the thigh.

In the presence of great separation of the lesser trochanter it may be necessary to cut down, overcome the displacement and retain the lesser trochanter or epiphysis *in situ* by means of a bone-peg. Operative access to the lesser trochanter may be had through the inner portion of the floor of Scarpa's triangle, in the interval between the adductor brevis muscle internally and the pectineus externally, the limb being flexed and rotated outward. The incision should be made along the outer border of the adductor longus muscle as a guide. This interval is free from any important vessels, and the only structure of consequence liable to be injured is the obturator nerve, which may be pushed upward with the handle of the scalpel.

INDICATIONS FOR THE USE OF MOSETIG-MOORHOF'S IODOFORM WAX BONE-FILLING

DR. ASTLEY P. C. ASHHURST read a paper with the above title, for which see page 227.

DR. GWILYM G. DAVIS thought that many people had been deterred from using this bone wax because of the difficulty of having it retained, and heal in by primary healing. His experience had been the same as that of Dr. Ashhurst, that in cases in which it does not heal in entirely or in which there has been a certain amount of suppuration, it still seems to have a distinctly good effect in hastening the healing process. In many cases it is practically impossible to close the cavity by depressing the skin from the sides and it is especially useful in this class of cases.

DR. EDWARD B. HODGE had used the wax a good deal and had also felt that while it does not always give a primary cure it has never done any harm, and has always helped in a measure. He had also had success in using the bone wax as a secondary dressing, so to speak. If he could not get the cavity dry at the time of the primary operation he would pack the wound, and when at a subsequent dressing it was found dry, fill the bone cavity with the wax.

DR. ASHHURST, in closing, said that he had tried to sterilize the cavity in various ways—hot air blast, radiations from the actual cautery, carbolic acid, iodine. With none of them can one get perfect sterilization when the cavity was primarily infected. Mosetig-Moorhof laid great stress on having the cavity dry. He would use the hot air blast until the shine of the moisture had vanished.

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PYLORIC AND DUODENAL ULCER

DR. JOHN B. DEAVER presented a series of lantern slides (see Figs. 2-II). He said his purpose was to elicit views upon the surgical technic in the treatment of these ulcers. Taking up first ulcers of the stomach; we know their most common site is on the posterior wall along the lesser curvature, near the pylorus; next most common site lesser curvature distant to the pylorus and the anterior and posterior walls. The least common site, in the fundus and to the side of the entrance of the œsophagus. When possible all ulcers of the stomach should be excised; this is practically always possible where they occupy either the anterior or posterior wall of the stomach. When the ulcer is on the posterior wall the excision is made transgastrically. When the ulcer is small and on the lesser curvature it can be excised and the stomach walls repaired without interference with its mechanics. Where the ulcer is large and on the lesser curvature, and particularly when of the saddle-back type, involving both walls, central resection with end-to-end union is the operation of choice, a gastro-enterostomy not being necessary, at least he had not found it so. In pyloric ulcer with considerable induration he believed the better practice is to do pylorectomy, at least this is the technic he practised. Ulcers in the fundus and around the œsophageal entrance are practically inoperable, at least those that have come under his observation have been. He believed, however, if these were diagnosed very early by making a gastrotomy in doubtful cases, much can be accomplished.

It is a well recognized fact that duodenal ulcer is more frequent than gastric ulcer. Duodenal ulcer is most often located upon the anterior and lateral wall of the first portion of the duodenum. The next most common site is the posterior wall of this portion of the intestine, and the least common site the inner pancreatic wall of the second portion of the duodenum.

Where the ulcer is small and located upon the anterior wall of the first portion of the duodenum it is his practice to excise it, close the opening in the intestine, plicate the duodenum and make a posterior gastro-enterostomy. When an ulcer in this portion of the intestine is large, but extending short of the head of the pancreas, he amputated the duodenum below the lesion, purse-string it, invert, excise the pylorus, and make a posterior gastro-enterostomy. When the ulcer is on the posterior wall of the first portion of the duodenum and not too adherent to the posterior abdominal wall to permit of freeing the duodenum, he practises the same technic as in large ulcers upon the anterior wall.

When the amputation of the duodenum is made so close to the head



FIG. 2.

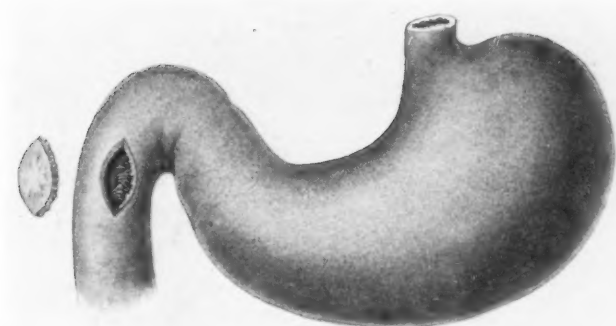


FIG. 3.



FIG. 4.

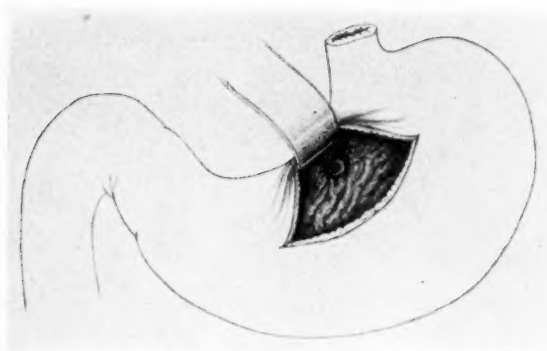


FIG. 5.

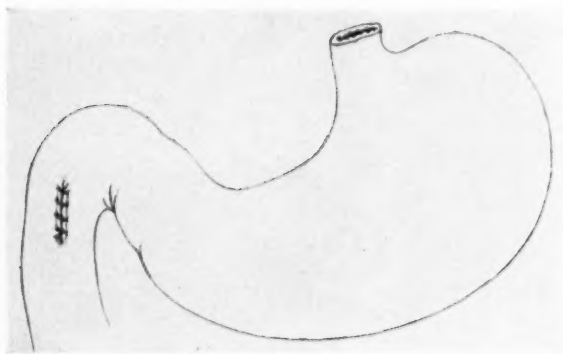


FIG. 6.

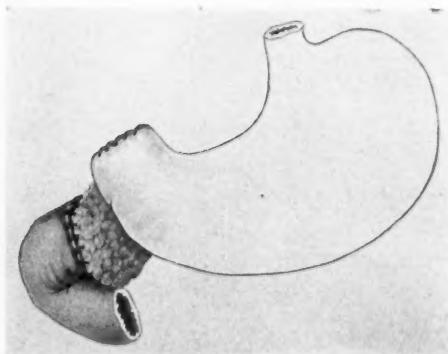


FIG. 7.

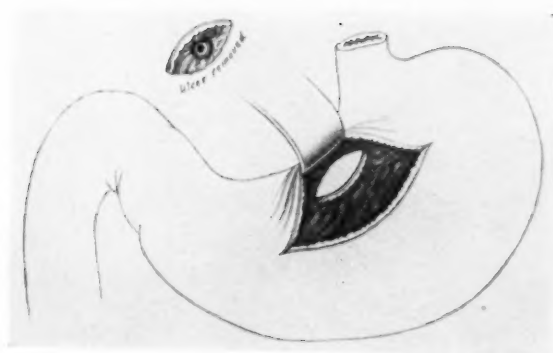


FIG. 8.

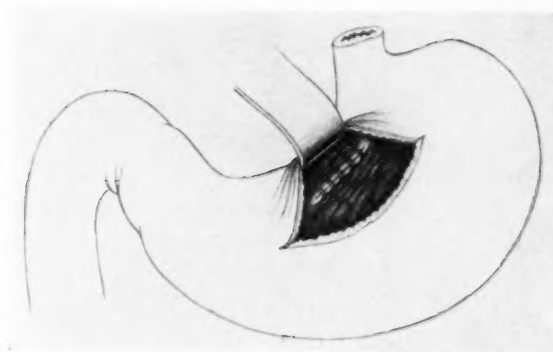


FIG. 9.



FIG. 10.



FIG. 11.

THE TECHNIC OF PELVIC FLOOR REPAIR

of the pancreas as to preclude the use of the purse-string suture and inversion, he adopted one of two procedures, namely: (1) Dissect the inner wall of the duodenum free from the pancreas (taking care not to injure the common bile-duct), purse-string it, invert and reinforce line of duodenal stump with great omentum, or if this cannot be safely done, (2) close the end of the duodenum with a continuous chromic catgut, stitch and sew the head of the pancreas over the duodenal stump. This he had done in many cases with good results up to the present, except in one instance. The chief point for discussion in the latter technic is the effect that the pancreatic ferments may have upon the transplanted duodenal stump, or, per contra, the possibility that the infection from the duodenal stump may be communicated to the pancreas.

In acute perforation of a duodenal ulcer it is his practice to make a posterior gastro-enterostomy at the primary operation. He had now operated upon forty-six patients in this manner with but one death. His reasons for advocating this procedure are, first, in order to place the ulcerated area immediately at rest; second, to secure the ultimate advantage of the operation which is curative in many cases, and third, because his experience with it has been so satisfactory as to entirely outweigh any theoretical objections that may be made against it.

Posterior gastro-enterostomy when the ulcer is located other than at the pylorus does but little, if any, good, therefore it is a useless procedure from the standpoint of cure. If posterior gastro-enterostomy does any good in this condition, it is only by allowing bile and pancreatic juice to enter the stomach, thus producing a neutralizing effect upon the acid contents of the stomach. That this operation accomplishes good by drainage alone he thought doubtful. The operation accomplishes most good where there is pyloric obstruction and where the ulcer has been excised.

THE TECHNIC OF PELVIC FLOOR REPAIR

DR. BARTON COOKE HIRST presented a series of drawings, remarking that the poorest work seen in surgical and gynæcological clinics to-day is the repair of the injuries of childbirth in the female genital canal. It is curious that this should be so, for of all the women who consult a physician for something peculiar to their sex, more than half suffer from these injuries and the most frequent of them is the laceration of the pelvic floor.

There are several reasons for this condition of affairs. First and foremost comes the foolish practice of immediate repair. This cannot be done successfully and no surgeon of experience, with the right sort

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of surgical instinct, would attempt such operative work on bruised and distorted tissue, with a profuse blood discharge obscuring the field of operation, the operation being done probably in the middle of the night without proper assistance, implements or light and on the patient's bed. Nevertheless, the majority of the professors of obstetrics in this country advocate the immediate repair of lacerations of the birth canal.

This brought him to another reason for lack of progress in this work. The American specialist in obstetrics is usually the victim of the provincialism, peculiar to this country, of separating the surgical treatment of the diseases of women from obstetrics, so that the teachers of a branch requiring an expert's ability in surgery, have often had no surgical opportunities, training or experience. Consequently, their view on any surgical subject is not authoritative. Finally the surgeons and the so-called though misnamed gynæcologists, who see only the smaller part of the physiology and pathology of womankind, have no knowledge of the nature of the injuries experienced in childbirth and no experience with the result of their surgical repair on subsequent labors.

There are three principles that must govern this work: *First*, the anatomy of the region must be understood; *second*, the operator must know what happens to a woman who is injured in labor, and, *third*, each damaged structure should be restored to its original condition.

It is unnecessary to dwell on the anatomy of the pelvic floor—all are supposed to be familiar with it. It is very necessary in an association like this to point out what happens to the pelvic floor when it is lacerated in parturition. The following is a list of the damage done: (1) The levators are torn loose from their attachments to the pubic and ischial rami, the tear running obliquely inward and downward and not usually involving the whole thickness of the muscle, which is therefore spread out, as it were, and much increased in length and tenuity. (2) The perineal centre is torn through, as a rule, separating the junctions of the superficial and deep transverse perineal muscles and the constrictor vaginae. (3) The layers of the triangular ligament are torn where they fuse with the perineal centre, leaving a gap through which the rectocele protrudes.

Colles's fascia is naturally torn if the perineal centre is injured. The illustrations presented herewith show each step of the operation for the separate repair of all these structures. By cutting through both layers of the triangular ligament the levator is made accessible above the superior layer, the deep transversus perinæi is exposed between the two. The latter is always retracted and must be fished out of the cavity in which it lies. The posterior column of the



FIG. 12.—The result of laceration of the levatores ani, deep transversus perinei, fused layers of the triangular ligament, perineal centre, junction of superficial transversus perinei and bulbocavernosus muscles and of Colles's fascia. Note the low situation of the anus.

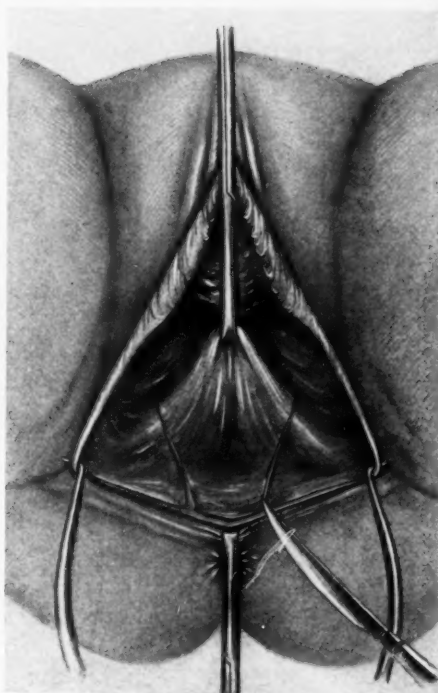


FIG. 13.—A convenient incision for the denudation to expose the injured muscles and fascia.

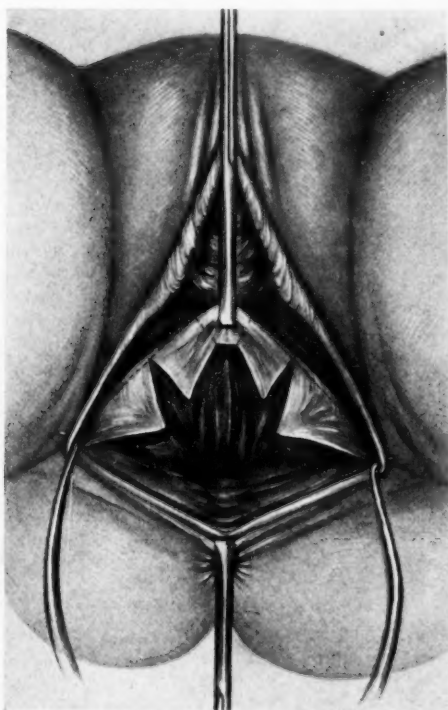


FIG. 14.—The denudation practically accomplished—to be completed by removing the mucous membrane within the dotted lines.



FIG. 15.—The incision through both layers of the triangular ligament to expose the levatores and the transversus perinei profundus.

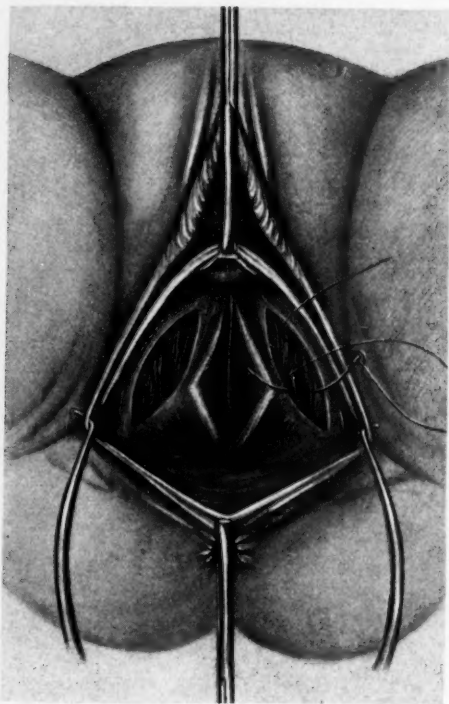


FIG. 16.—The levatores exposed and the cleft in them united by a two-tier suture.

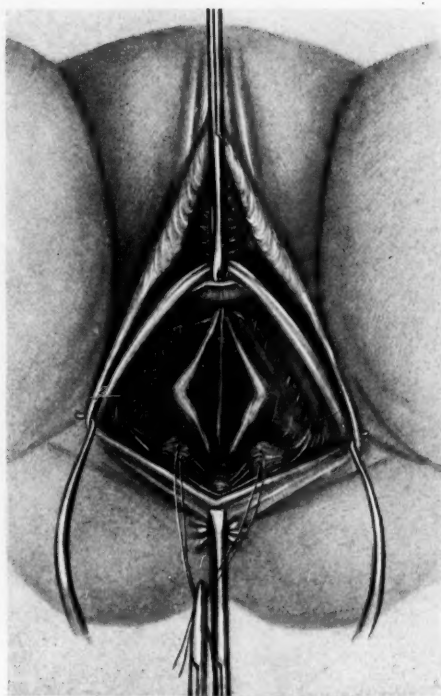


FIG. 17.—The levatores repaired and the deep transversus caught by two sutures and united at the base of the perineal body to give this muscle its original triangular shape and to restore its lifting power on the perineum.

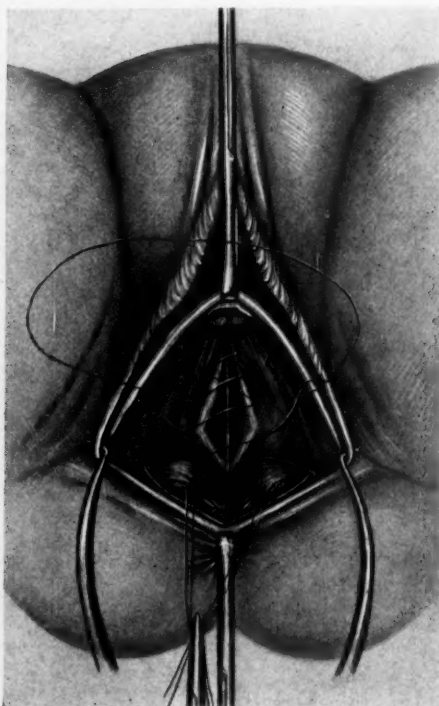


FIG. 18.—The cleft in the central fascia and the fused layers of the triangular ligament closed. It is through this cleft that the rectocele protrudes.

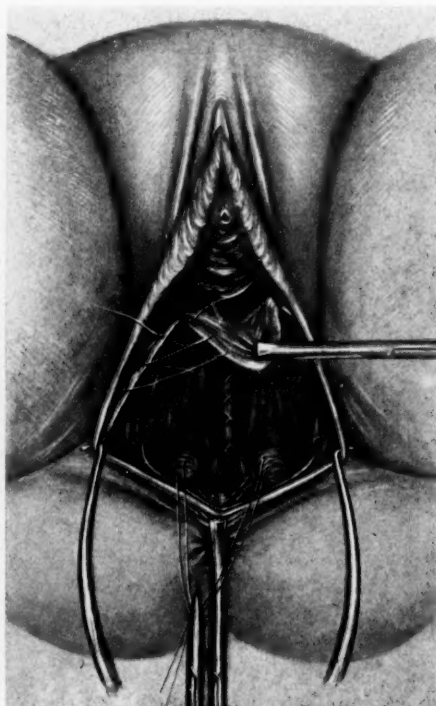


FIG. 19.—The triangular extensions of the denudation in the sulci closed.

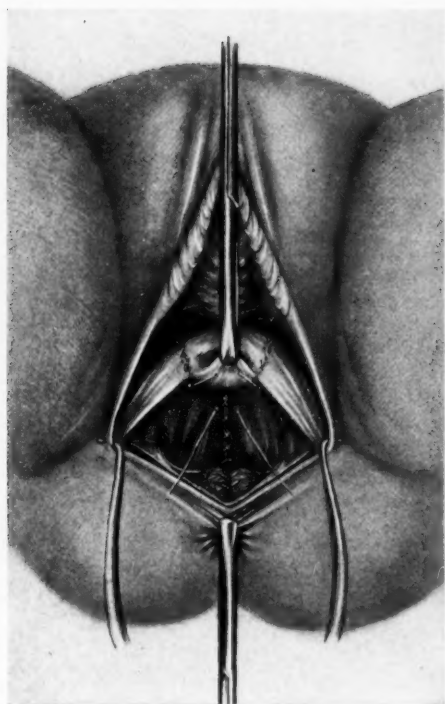


FIG. 20.—The posterior column of the vagina fixed in its normal position.

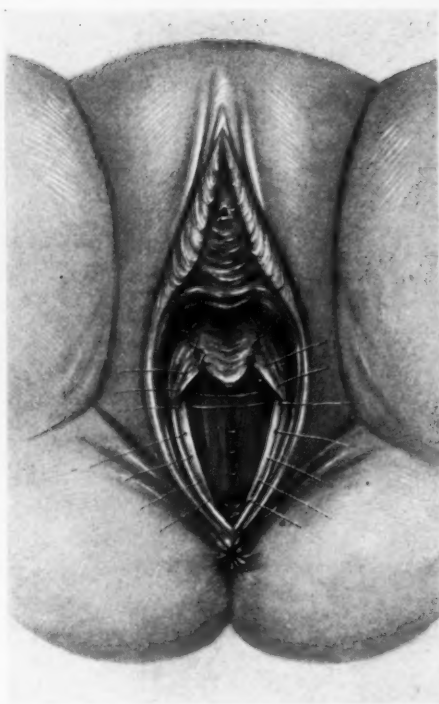


FIG. 21.—The perineal centre and Colles's fascia closed by interrupted sutures.

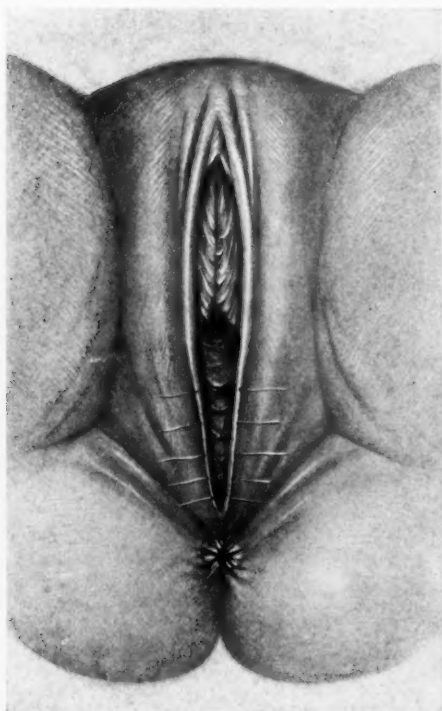


FIG. 22.—The skin of the perineum closed separately, burying all other sutures.

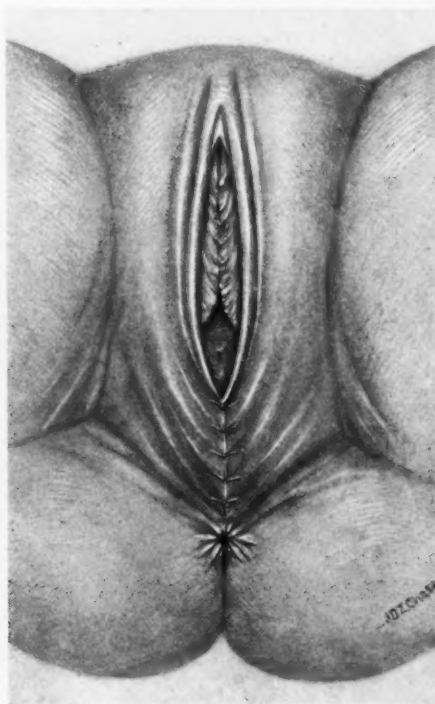
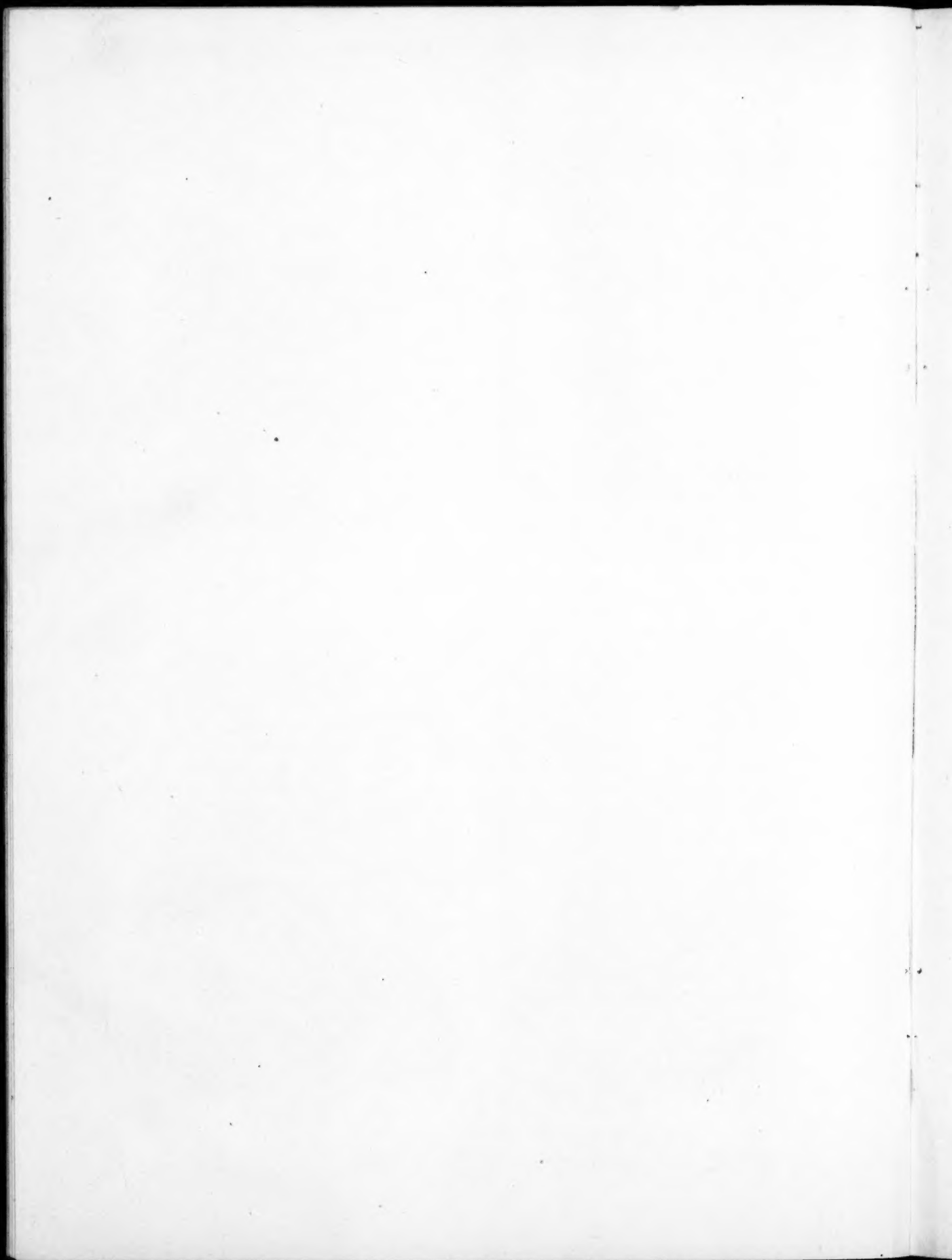


FIG. 23.—The operation concluded. The skin stitches are No. 1 extra hard chromic gut. All the other sutures are No. 1 chromic gut.



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vagina is fixed in its normal position. The same stitches unite the perineal centre and Colles's fascia. The skin is united separately.

DR. RICHARD C. NORRIS said that any one doing much obstetric work will find that in many instances of pelvic floor injury the levator muscles and fascia are separated from their bony attachments. There are, however, many more cases in which the injury is confined to the more central portions of the pelvic floor, the levators being separated from the rectum, and in which separation from the bone has not occurred and which can be primarily repaired with success. It is his practice to do immediate repair of the perineum and the pelvic floor because in a large majority of instances the injury is of the latter type. By careful examination immediately after labor, if the injuries do not extend to the bony attachments, a good result follows from the primary operation. Furthermore, in private practice it is a serious disadvantage to allow an open wound to remain in the vagina for a week or ten days and then to suggest that the patient should undergo an operation with its entailed anxieties, just when the household has recovered its equilibrium and is ready to enjoy the baby's arrival in the home. Practically always one can have the patient do as advised, but sometimes patients resent this to such an extent that they will go to another obstetrician in a second labor. This, of course, is not a justification for doing the wrong thing. The cervix, moreover, when not a source of hemorrhage, if left alone, will often repair itself spontaneously. If repaired too early there may be interference with the discharge from the uterus. Excessive lacerations should be repaired early. His practice was not to delay more than six or eight weeks—at the end of the involution period—and the patient is better satisfied to have this slight operation at this time. The essential point in Dr. Hirst's paper was the need of careful study of the kind of injuries the woman has received. If in these extensive lacerations there has been separation of the fascia from the bony attachments an operation must be devised to meet the conditions. This requires skilled obstetric and gynecologic service. In these excessive lacerations, however skilful the repair, one never can wholly restore the vaginal floor to its original anatomical conditions, and recurrent pregnancies and labors will undo the handiwork of the most skilful gynecologist. In primiparae with rigid infantile types of vaginas, in which one can foretell these destructive injuries, an extensive so-called episiotomy, in reality a deep incision through the levator muscles and fascia, alongside the rectum, will prevent injuries reaching to bony attachments, and the incision can be satisfactorily repaired immediately after labor.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY

Stated Meeting, Held November 8, 1916

The President, DR. CHARLES N. DOWD, in the chair

VOLKMANN'S ISCHÆMIC PARALYSIS

DR. ALFRED S. TAYLOR presented a boy, whose case was described in detail in the paper read by him, for which see *ANNALS OF SURGERY*, January, 1917, p. 28, being the second case.

On June 20, 1911, the boy fractured the lower end of the ulna a short distance above the wrist. The arm was put up within two hours of the time of fracture in wooden splints. They were tied on very firmly, and the doctor put the arm in a sling, and disappeared. Within an hour of the time the splints were put on there was extreme pain, considerable swelling, cyanosis, and blebs on the hand, and within a short time thereafter the boy developed delirium because of the pain, and had some temperature and constitutional disturbance. This was reported to the attending physician, but, with the statement that all fractures were painful, he refused to come and look at the child, and did not come for four days. At the end of that time the splints were removed and it was found that the hand was rigid, there was a slough on the ulna side of the forearm and the wrist, there was a large slough on the flexor aspect of the forearm just below the elbow. It took about three weeks for these infected areas to heal. On the fourth day, when the splint was removed, there was a rigid contracture of the muscles of the forearm. This contracture progressed rapidly until within a short time there was extreme development of the typical Volkmann's ischæmic paralysis.

Nothing was done about the contracture part of the difficulty, the parents being told that this would take care of itself in time, with massage and with the natural use that the child would give to his arm. However, in the middle of August, which would be just about two months from the time of the original injury, the mother noticed, accidentally, that a pin which had happened to stick into the palm of the hand sufficiently to draw blood did not attract the attention of the child to the fact that he had been stuck with the pin. She immediately decided that this represented paralysis, and then insisted that the doctor come and look at it, and also insisted on consultation.

VOLKMANN'S ISCHÆMIC PARALYSIS

It was on August 16 that the child was taken to a surgeon, who said that it was typical Volkmann's ischæmic paralysis, that nothing would give any promise except resection of both bones, and that even that gave very little promise of a satisfactory result. In other words, following the diagnosis, there was a very bad prognosis given—that no form of treatment would give much promise. This is mentioned merely to indicate that the case looked like one of extremely severe type. When brought to Dr. Taylor shortly after that, he presented a perfectly typical, well-marked ischæmic contracture. There was absolute anæsthesia in the ulna nerve area, and there was a very marked hypæsthesia in the median nerve area of the hand. The hand was so rigid that hardly any motion of extension could be brought out on using considerable force, and very little motion in flexion at the wrist. A previous experience with operative interference in these cases had led him to think that operation was perhaps not the best method of procedure; so that he applied, in this case for the first time, the method described in the paper. The brace devised by him was fastened on the forearm, then with a round spool under the fingers, an elastic was led from each end up to the notches above, so that one got a steady, lasting pull and as soon as the muscles yielded at all the elastic would take it up, in that way causing an easy, painless, but persistent extension of the cicatricial tissues. Within four days the parents said that the hand was coming up pretty readily, and within thirteen days it was necessary to change the angle of that brace from about forty-five degrees up to the full ninety. That was on August 29; that was within nine days, you see, the brace having been first applied on August 20. On October 7, when they brought him into town again, the hand was nearly normal in color, it had normal temperature, and the sensation in the ulnar area was almost normal; the sensation in the median area had entirely recovered. In other words, with the stretching of the cicatricial contracture, there had been complete recovery of the function of the ulna and median nerves. The cicatricial mass in the forearm had distinctly softened, he was beginning to get active motion, the interossei muscles, which had been considerably atrophied as well as completely paralyzed, were again resuming their function and had increased somewhat in size.

At the end of December, which was about four months and a half from the time of beginning treatment, the hand and arm were perfectly well—that is, he could do everything that he chose with it, and sensation and color and everything else was perfectly normal.

The boy now can do practically anything with that hand. The only thing which still suggests the fact that he has ever had a Volk-

mann's ischæmic paralysis is that when you come to extend the hand and wrist you get just a little resistance at that angle. He plays violin and he plays piano.

TRAUMATIC RUPTURE OF THE BRACHIAL PLEXUS

DR. ALFRED S. TAYLOR presented a man who, in July, 1915, while diving, happened to strike his shoulder on a submerged pipe. When he came to shore again he found that there was absolute loss of power in the right upper extremity, and that there was a very considerable degree of pain in the extremity.

There was found to be a fracture of the clavicle at just about the middle. It healed in a faulty position, with the outer end of the inner fragment depressed downward and backward, presenting a rather ragged edge toward the brachial plexus. Because of the persistent paralysis he saw various consultants, surgeons and neurologists, who advised that he wait for six or eight months to see what would happen by Nature's healing methods. During that time nothing happened in the way of recovery, and finally he came to the Neurological Institute. There was loss of power in the arm, there was a very considerable degree of atrophy, some of which still remains. He could make certain motions with the fingers and slight motions with the wrist; he could not flex the elbow, he could not rotate the arm externally; there was slight power of abduction at the shoulder. An exploratory operation was done on December 21, 1915—that was some five months following the injury. A dissection at the base of the neck demonstrated that the nerve roots coming from the spine were practically normal in appearance, but that, following the roots, underneath the clavicle, they ran into a dense mass of scar tissue. A subperiosteal resection of the clavicle at the site of fracture was done, and the bone ends and the callus all removed. The posterior layer of the periosteum was split in order to expose the nerves which were lying underneath. In doing that, a bundle of nerve was found involved in the periosteum and the scar tissue. That was dissected out carefully. It was followed over and found to be the seventh root which had been distorted from its exit at the spine over to the site of fracture; then it was found to run back, and then down into the axilla. In other words, there were three sharp kinks in the main trunk of the seventh nerve. The fifth and sixth nerves were found to have been torn at a level just about back of the clavicle, and they were the site of dense scar tissue, which would absolutely prevent the passage of any nerve impulses. The eighth cervical and first dorsal nerves were found to be involved in scar tissue and pinched in such way as to prevent physio-

TRAUMATIC RUPTURE OF BRACHIAL PLEXUS

logical function, but they evidently had not been otherwise damaged. Therefore, the fifth and sixth were resected until one got good nerve bundles above and below; and the seventh, where it had been seriously damaged in part of its course, was also resected; and then was done an end-to-end anastomosis between the ends of these nerves. About two and a half centimetres or an inch of nerve tissue with scar was excised.

It was interesting that the second day after the operation, sensation in the ulnar side of the hand had returned. Preceding that time it had been numb. In other words, the eighth cervical and first dorsal, having been pinched by scar tissue only, had resumed function two days from the time of their release from scar pressure. On the fifth day he for the first time was able to use his interossei muscles, they also being controlled by these same two roots.

From that time there has been steady progress to recovery. He has been quite faithful to his massage and electricity and all the other methods of physical therapeutics advised. He is a mechanical engineer, and he has gotten now so that he can again use his pencil for drawing and writing and things of that sort. In other words, he has now recovered motion in every single one of the muscles of that extremity. The full range of motion is not yet there, and of course there is still a great deal lacking in power.

DR. HOWARD LILIENTHAL presented a boy who was admitted to Mt. Sinai Hospital on April 27, 1907, five and a half months following a fracture of the elbow with resulting ischaemic paralysis, with the characteristic infantile hand, hyperidrosis, etc. On April 29 a well padded dorsal splint was put on for four hours and then removed. A beginning skin necrosis was found at the back of the wrist, so this method of treatment had to be abandoned. On May 24, 1907, he resected the radius and ulna, inserting an Elsberg intermedullary aluminium splint into the radius. The ulna came together nicely without splint or plate. For complete report see ANNALS OF SURGERY reference in Dr. Taylor's bibliography.

There was some immediate improvement, and a number of months later the hand showed less sweating and seemed somewhat improved, but there was not as much gain as had been hoped for. A few years later he returned with his Volkmann's paralysis as bad as ever, the contracture having recurred. A piece of muscle taken out at the time of the first operation showed interstitial myositis with atrophy. This patient was transferred to the physiotherapy department of Mt. Sinai Hospital and Dr. Wolf, chief of the department, stated that he could not do anything for him.

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Dr. Lilienthal then determined to try an arthrodesis of the wrist, which would probably prevent recontracture, while the hand was placed in sufficient extension to permit the flexor tendons to work normally.

On February 24, 1916, he performed this operation in a rather atypical manner. Incision was made at the back of the hand between the little and the ring finger. The wrist was easily exposed but the landmarks were changed on account of the atrophy of the bones. Without regard to anatomy he chiselled out what he thought was the greater part of the mass of carpal bones in one horizontal plane and chiselled off the extreme articular face of the radius, then bringing the two chiselled surfaces together and placing the hand in extension with the fingers flexed around a roller bandage. The hand was also placed in a state of abduction. At the end of the operation he thought that he had denuded the heads of some of the metacarpals and that he had gotten rid of most of the carpal bones. Following a primary union the X-ray demonstrated that the section had gone through the os magnum and unciform, the os magnum being in contact with the end of the radius.

As a result there has been very great improvement, the hand has developed rapidly and the patient is able to do far more than he was able to do before the operation. However, voluntary flexion of the interphalangeal joints is still most defective, probably because of the contraction and atrophy of the bellies of the affected muscle.

The case is presented as exemplifying a new operation—arthrodesis of the wrist for the relief of Volkmann's ischæmic paralysis with contracture. He believed this operation to be much more likely to succeed and to be less dangerous than resection of radius and ulna. In view, however, of what Dr. Taylor has told us, he was convinced that operation should be deferred until it was quite certain that Dr. Taylor's method cannot succeed.

DR. ROYAL WHITMAN presented a boy ten years of age, illustrating a severe type of ischæmic contraction. This was the result of a fracture of the humerus in 1914. He was first seen in June, 1915. There was a typical and resistant contraction of the wrist and fingers, extensive scarring of the flexor surface of the arm and loss of sensation in the fingers and the greater part of the hand.

The correction of the deformity had been accomplished by the Jones method, supplemented by a long incision on the forearm, through which some of the more resistant tissues were elongated and the compression of the fascia relieved.

The patient had not been seen for a year, although according to

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the mother, massage and stretching begun at the hospital had been carried out during the interval. The deformity had in some degree recurred, but the improvement had been marked. Sensation had returned in the little finger, and the interossei are active. It would appear that further corrective treatment might now be undertaken with advantage.

This case was one of five under observation at the Hospital in 1915. One was easily corrected by mechanical means, the four others were of the most resistant form, in one of which a resection of the bones of the forearm had been performed previously in another hospital without effect. These were treated as described.

SPINA BIFIDA: POST-OPERATIVE HYDROCEPHALUS

DR. CLARENCE A. MCWILLIAMS presented a boy baby, two weeks old on admission, who was normally born at term and was breast fed up to time of admission. Mother and father both well, also one other child now two years old. The parents noticed a sore on the lower part of the back at birth and also double club feet. On examination of the back there was seen over the lower lumbar and sacral regions a pear-shaped ulcer 6 x 4 cm., irregular and covered with sloughs and with reddened skin about it. There was a thin yellowish discharge on its surface. In the lower posture of this area there was a small, slightly bulging, blister-like area, about 2 mm. in diameter, which looked like a thin membrane over clear fluid. No spinal fluid was seen. The edges of the ulcer were raised, red and indurated. A wet dressing was applied for several days to the ulcer. The child's head was normal and there was no evidence of hydrocephalus. There was double talipes equinovarus. The child did not move the legs or feet and could not be made to cry out on sticking a pin into either foot or leg. The sphincters were not thought to be involved because there was no continuous discharge from anus or penis. After several days the sac ruptured and thereafter there was a more or less continuous discharge of spinal fluid through an opening, the size of a knitting needle, in the lower part of the ulcerated area.

The outlook for the child seemed desperate either with or without operation. A certain small proportion of such patients have been found to be paralyzed owing to the pressure of the distended sac upon the nerve filaments, relief of this pressure improving the paralysis. Rupture of the sac had removed this pressure but this exposed the child continuously to the danger of infection of the sac and spinal membranes. He did not know what proportion of such patients develop hydrocephalus as the result of the successful closure of the sac, neither

did he know of any method of telling beforehand whether this will subsequently happen.

The parents agreed to the operation, so on September 14, 1916, the child was placed prone on a hot water bottle and a few drops of ether were administered. For two days prior to the operation a weak green soap poultice had been applied to the ulcerated area. A probe was inserted through the opening in the sac upwards and the tissues were found to be very thin. These were split vertically upwards. The opening in the neck of the sac was no larger than the blunt end of a lead pencil. Externally two elliptical incisions were made between the lateral skin and muscles and the sac which was dissected free down to the neck. On one side what looked like a good sized nerve was preserved, the remainder of the sac was cut away, the nerve was reduced through the opening in the neck and the sac edges were sewn together, closing the neck. Two small flaps were fashioned from the immediate tissues on the sides and were brought together edge to edge and sutured with plain catgut. Two larger flaps were then made, hinged internally, out of the vertebral aponeuroses on the sides. These were turned inwardly one upon the other and were sutured with mattress chromic catgut interrupted sutures, as in an umbilical hernia operation. The edge of the more superficial flap was then sutured to the tissues on the side with chromic catgut. The indurated edges of the skin were trimmed away. It was necessary to undermine the skin edges extensively before they could be brought together without tension. Silk-worm gut sutures were used. There was no drainage of the wound. The convalescence was uneventful. The wound did not suppurate and there was no evidence of meningitis. The skin edges of the wound separated and it was too weeks before it was tightly healed. The child left the hospital in excellent condition. On returning, three weeks later, it was discovered that the fontanelles were beginning to bulge. Now there is well marked hydrocephalus. Suggestions from the members as to the best method of treating this condition would be welcome.

DR. ALFRED S. TAYLOR said that the statements in the books that operation on spina bifida causes hydrocephalus ought not to be taken too seriously. A spina bifida and hydrocephalus are things which are apt to occur in the same child from the same abnormality in development, and the mere closure of a little sac the size of a hen's egg could have nothing to do with the development of hydrocephalus. As a rule the spina bifida is present at birth, and hydrocephalus usually begins three or four months after birth. If the spina bifida is operated the operation has no relation to the development of hydrocephalus—



FIG. 1.—Before operation.

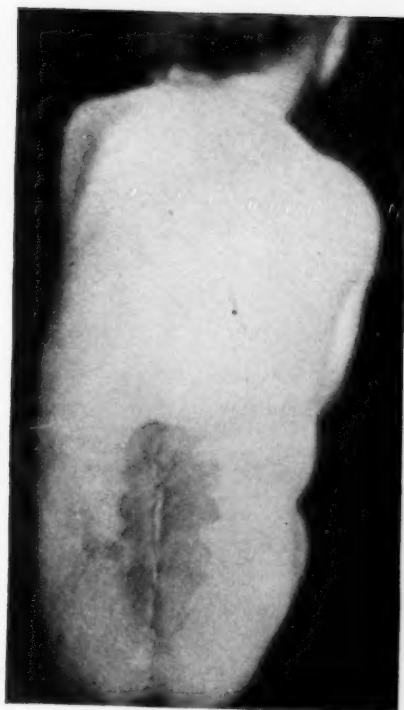
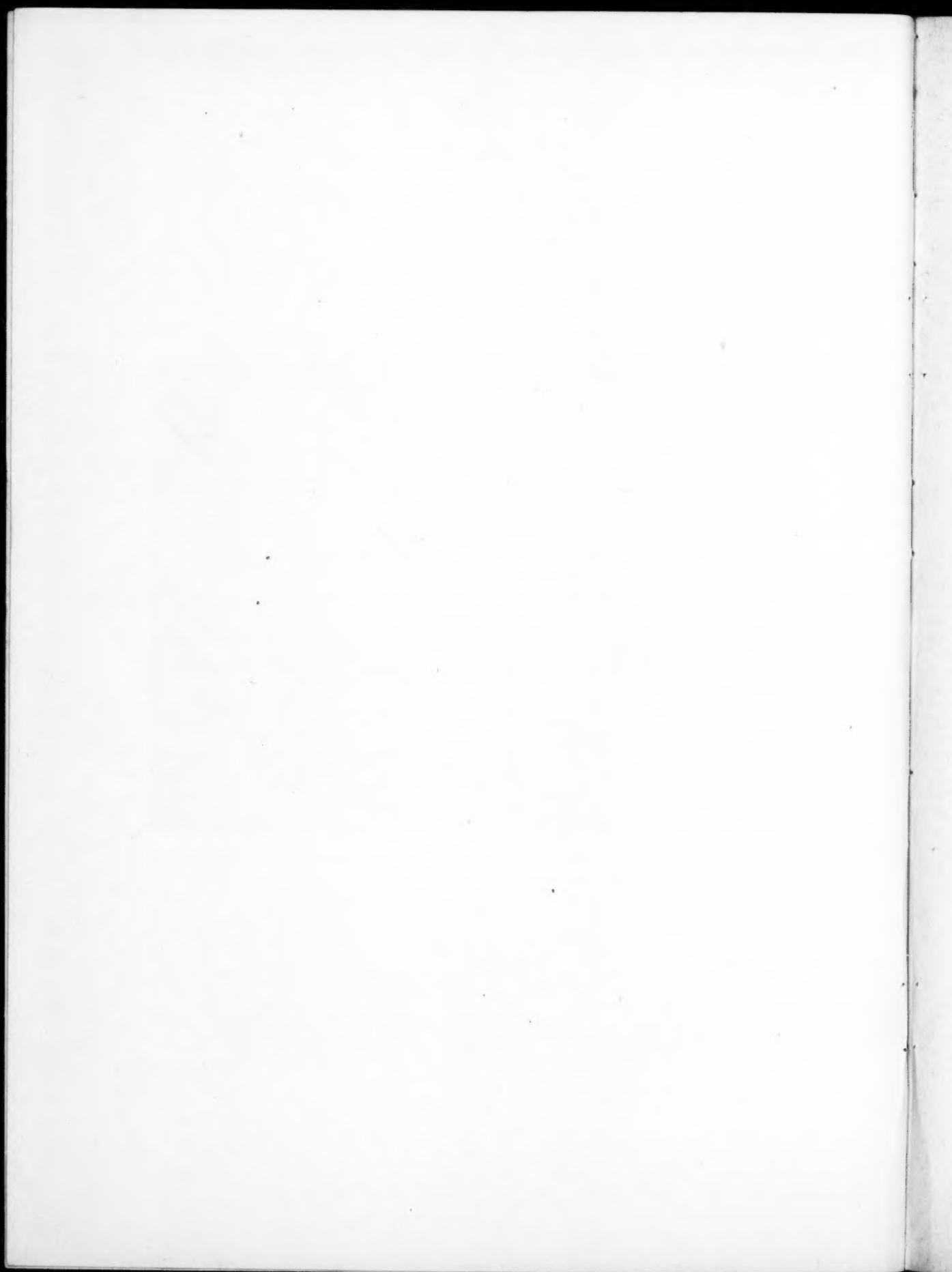


FIG. 2.—A month and a half after operation.



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that it will develop because of the operation. In a large number of these cases hydrocephalus occurs when nothing has been done to spina bifida, so that the two perhaps result from the same cause, but that the one does not aggravate the other.

DR. ARTHUR L. FISK said that he operated, over nine years ago, on a case of spina bifida similar to the case shown by Dr. McWilliams. The patient had been seen by him two weeks ago, and she has no hydrocephalus. He had observed hydrocephalus occur after operations for the cure of meningocele, or spina bifida high up in the spinal column.

DR. CHARLES N. DOWD stated that in an infant, upon whom he had successfully operated for spina bifida in 1915, a moderate degree of hydrocephalus had developed by the end of a year.

DR. CHARLES A. ELSBERG said that for a number of years he had hesitated to operate on patients with spina bifida if there was a hydrocephalus. Since we have the operation of puncture of the corpus callosum, in which a communication is made between the ventricles and the subarachnoid space over the convexity, he had operated on quite a number of these patients who have hydrocephalus. He usually first tests the absorptive power of the subarachnoid space and learns whether there is an obstructive hydrocephalus, by means of neutral phenolphthalein injected into the subarachnoid space and into the ventricle. Having determined the kind of hydrocephalus, he first punctures the corpus callosum and follows it by the spina bifida operation. Recently he had not a single instance of rapid increase of the hydrocephalus after this procedure.

DR. LAMBERT agreed with Dr. Taylor that the two conditions—hydrocephalus and spina bifida—often accompany one another, and it is very questionable whether the closure of the small sac of the spina bifida necessarily results in, and gives rise to, the hydrocephalus. His experience, however, did not entirely agree with that of Dr. Elsberg in regard to the phenolsulphophthalein test as a measure of the absorptive power of the subarachnoid space. It only establishes the fact that the absorptive power from the subarachnoid space is normal in regard to the drug, but is no indication as to whether it is able to absorb the amount of cerebral spinal fluid which is secreted, and with the non-obstructive form of hydrocephalus present—that is the hydrocephalus of the communicating type—it is in no sense a sure indication as to whether the closure of the spina bifida will, or will not, be followed by the development of a hydrocephalus. In the obstructive form of hydrocephalus the corpus callosum puncture has been a successful procedure for a short space of time, but in my hands has not given permanently brilliant results.

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LATE RESULT OF SPLENECTOMY FOR VON JAKSCH'S ANÆMIA

DR. E. H. POOL presented the same child who was shown at a meeting of the Society in October, 1915. The spleen was removed eighteen months ago for von Jaksch's anæmia: she was then in extremely bad condition; splenectomy improved her condition rapidly. Dr. Pool presented her again to demonstrate that the improvement following the splenectomy had been lasting.

The child was admitted to the New York Hospital with a moderate grade of rickets; anæmia, and enlargement of spleen. The details were given in the former presentation before this Society October 13, 1915. (*ANNALS OF SURGERY*, Vol. lxiii, Jan., 1916, p. 122.) After considerable study and treatment her spleen was removed on May 1, 1915. No transfusion was made. Immediately she began to show improvement. During the three weeks after the operation her red cells rose from 2,700,000 to 4,500,000 and hæmoglobin from 45 to 60 per cent.

The diagnosis of von Jaksch's anæmia was based on the well-marked anæmia, leucocyte count and large spleen associated with rickets in an infant. Histological examination of the spleen confirmed the diagnosis. The spleen showed extreme grade of myeloidization of the pulp with atrophy of the Malpighian bodies.

This case can properly be considered as belonging to the group known as infantile pseudo-leukæmia described by von Jaksch. Following her splenectomy she improved and has continued her improvement for a period of eighteen months, and is now apparently in good health. There is still the same striking change in the blood picture which was noted in the last report, namely, the percentage of mononuclear cells is much higher than one would expect.

Blood examination October 20, 1916; hæmoglobin 94 per cent.; R. B. C. 5,632,000; W. B. C. 15,000; polymorphonuclears 21 per cent.; small mononuclears 72 per cent.; large mononuclears 7 per cent. (Fig. 3).

NEPHROLITHIASIS AND PYONEPHROSIS IN CHILD

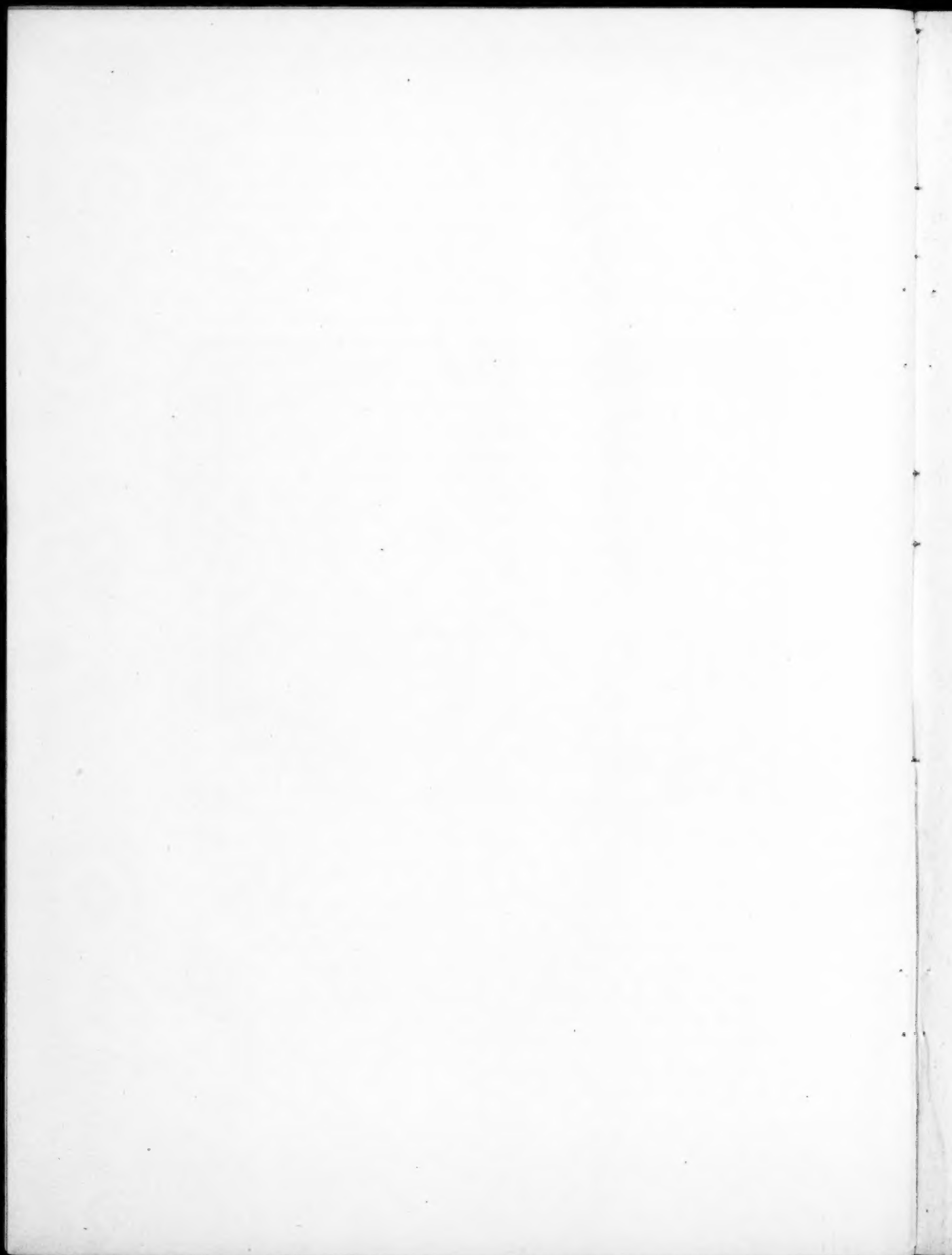
DR. E. H. POOL showed a boy aged four, who was admitted to the New York Hospital, Medical Service, with diagnosis of sarcoma of right kidney. The child had a very large abdomen, was weak, anæmic, and losing weight. X-rays (Fig. 4) showed a much enlarged right kidney with small calculus and a large stone in left kidney. There was pus in the urine. Temp. 99 to 101, W. B. C. 11,500, R. B. C. 3,520,000, Hb. 35 per cent. Wassermann negative. Von Pirquet: very faint. Moro: negative.



FIG. 3.—Von Jaksch's anæmia; splenectomy; present condition.



FIG. 4.—Nephrolithiasis and pyonephrosis in a child. Skiagram before operation.



NEPHROLITHIASIS AND PYONEPHROSIS IN CHILD

Operation was deferred for the following reasons: He was an extremely bad risk; both kidneys presented lesions; diagnosis uncertain; if malignant growth, operation not indicated; if inflammatory, he might be improved, diagnosis established and proper operative procedure undertaken.

Patient's condition grew worse. A diagnosis of right pyonephrosis was made by Dr. Wm. Williams and on December 11, 1915, the kidney was explored, found to be enormous and contained pus. It was drained. Patient was in very poor condition and nephrectomy did not seem warranted. He did not improve; urine contained pus. Patient seemed gradually going down hill and was septic. It was recognized that the pus kidney must come out, but there was a serious difficulty. The other kidney (the left) was enlarged and showed a large stone by X-ray; and it was considered probable that this kidney also contained pus. It too would eventually have to be operated upon. It seemed possible that there was some functioning tissue in the right kidney. It was thought advisable to conserve this tissue until the effect of operation on the left had been noted. It was therefore decided to operate upon the left kidney first, remove the stone, and later to do a right nephrectomy, when the function of the left kidney had become re-established.

Accordingly, on February 18, 1916, the child, in an extremely weakened condition, was brought to the operating room, and a transfusion of 220 c.c. made under local anæsthesia by Lindemann method, the mother acting as donor. The left kidney was then operated upon. It looked like a normal adult kidney. There were no visible inflammatory changes. The pelvic wall, which was thick and oedematous, was opened in the hope of being able to extract the stone without damage to the kidney itself. The stone could not be delivered without risk of tearing the pelvis across. Accordingly, while grasping the stone in a small sponge stick through the pelvic opening, the stone was pressed upward toward the cortex and an incision made through the cortex following the bloodless line. Very little bleeding occurred, and the stone was readily removed. Two transfixion stitches of plain gut placed through the kidney to approximate cut surfaces and the cut edges were overhanded with continuous plain catgut. The opening in the pelvis was then closed with fine chromic sutures, not penetrating the mucous membrane. A piece of fatty capsule was sutured over this and a cigarette drain tied to the flap of fatty capsule which came between the drain and the suture line in the pelvis. Patient voided urine for five days, then ceased voiding for twelve days, but discharged urine freely from left flank.

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The child picked up a bit and then started down hill again. A transfusion of 120 c.c. by Lindemann method was given March 28, 1915; mother as donor. Child always rallied wonderfully after the transfusions. Patient continued to improve and urinary discharge in left flank stopped. Child became septic and very anæmic. On May 27, 1916, a transfusion by Lindemann method was done, 235 c.c. of blood given from mother and then a right nephrectomy performed. Pathological report, pyonephrosis.

Patient slowly recovered. The wound healed after considerable sloughing and patient was discharged July 25, 1916. At that time he was up and about, cheerful, temp. normal. He has continued to improve, and is now in good health. Hæmoglobin 65 per cent.; R. B. C. 3,100,000; W. B. C. 6500; weight 28 lbs. Urine, acid, clear, trace of albumin. Few white blood cells, rare hyaline cast.

MULTIPLE URETERAL CALCULI AND PYONEPHROSIS

DR. E. H. POOL presented a man, aged twenty-eight years, who was admitted to New York Hospital on May 12, 1916, complaining of pain in left side and slight pain on urination.

Illness began six weeks before admission with pain in the left side intermittent in character. The pain was experienced only in the left upper quadrant, anteriorly and posteriorly. It did not radiate to the groin or elsewhere. Occasionally there was pain on urination. A heavy urinary sediment had been noticed. The physical examination was practically negative save for the surgical condition. There was tenderness in left flank, and a large, hard, slightly movable tender mass was felt deeply in left flank. Urinalysis showed large amount of pus.

Patient was studied in Medical Ward by Dr. Wm. Williams. X-ray showed a very unusual condition, that is a group of shadows which were interpreted as an accumulation of calculi in lower ureter (Fig. 5).

Cystoscopic examination by Dr. Bancroft: Right side normal. Left ureteral orifice projects from trigone like a nipple 1 cm. Impossible to enter even finest catheter. Right kidney functioning normally.

On May 20, 1916, nephrectomy for pyonephrosis and ureterectomy for stones in ureter. An oblique incision exposed an enormous kidney which consisted of a thin shell and many loculi. It was ruptured in separating and contained foul-smelling pus. Kidney was delivered. The distended ureter was approximately two inches in diameter. The vessels of the pedicle were ligated and cut and the ureter dissected downward about six inches. The ureter distended with pus was opened and the pus removed by aspiration; its wall was extremely thick. Probe passed down but could neither feel the stones nor enter the



FIG. 5.—*a*, X-ray showing nest of stones in lower ureter. *b*, photograph of calculi after removal.



FIG. 6.—Case III. Kidney and ureter removed together.



PARTIAL EXCISION OF BLADDER

bladder. A large rubber tube was passed down through the opening in the ureter and left in place. The patient was then turned on his back, the abdomen having been prepared before the operation, and an incision 3 inches long was made 1 inch above Poupart's. External oblique split. Internal oblique and transversalis separated close to Poupart's and the peritoneum reached and dissected mesially until the ureter containing tube was felt. The ureter was drawn out of the wound and dissected bluntly and without much difficulty upward and downward. Stones could not be felt, however, and an opening was made in the ureter and stone forceps passed down and twelve stones removed which corresponded in size and number to those in the X-ray. The reason the stones could not be felt with the probe which had been passed down from above was that the ureter made a bend just above the stones, which prevented the passage of the probe into the stone-bearing pouch. The ureter was ligated as close as possible to the bladder and cut off, the mucous membrane outside of the ligature being cauterized. Two rubber dams inserted in this wound and two silkworm stitches. Patient turned on side and kidney and ureter removed together *en masse* without difficulty (Fig. 6).

Patient had a smooth convalescence. Was discharged in thirty-one days.

Patient returned to hospital for observation four months after the operation. His general health was good; no complaint; both wounds solid with good muscle union. Exam. of urine negative; no pus.

PARTIAL EXCISION OF THE BLADDER FOR URINARY FISTULA COMPLICATING A PREVIOUS INGUINAL HERNIOTOMY

DR. BURTON J. LEE presented a man thirty years of age, who was admitted to New York Hospital in the service of Dr. Charles L. Gibson, February 7, 1916. His chief complaint was a discharge of urine as the result of a left inguinal herniotomy, performed for recurrent hernia about four weeks before at another hospital. There had been no leakage of urine for three weeks and three days following the herniotomy. Since then there had been a steady discharge of urine, accompanied by some left lumbar pain, dull in character, but constant. Patient stated that upon pressure over the left flank and inguinal region, the watery discharge from the sinus tract was increased.

Examination revealed a poorly developed and poorly nourished man who looked rather ill. There were scars in both inguinal regions. At about the middle of the left inguinal scar there was a discharge of fluid of the appearance and odor of urine. Over the left lumbar region, there was considerable rigidity which extended downward to

the region of the scar. The left kidney was not palpable. When the patient sat or stood up the discharge from the sinus tract was increased. The amount of urine passed per day through the urethra varied from 16 to 32 ounces. Urine analysis showed numerous pus cells and a persistently turbid urine.

Operation (February 14, 1916).—For closure of the urinary fistula. Through a midline incision, the peritoneal cavity was opened and the bladder was found firmly adherent to the anterior abdominal wall on the left side. The bladder was opened during the separation of adhesions. A finger introduced through this opening into the bladder and passed to the left entered the bladder saccule which was adherent just behind the old hernial wound. The bladder was freed by cutting frankly across this artificial diverticulum. The two openings in the bladder were then connected and the bladder closed with a row of continuous chromic gut sutures, not passing through the mucous membrane. A second row of interrupted chromic gut sutures was then passed through the first row of sutures. A sound was then passed through the severed distal portion of the sinus and palpated from without, above the anterior superior spine. At this point an incision was made down through the peritoneum, the small portion of the bladder wall remaining being covered by folding the peritoneum over it. The retroperitoneal space thus made was drained by a split rubber tube inserted through the flank.

Cystoscopic Examination.—By Dr. MacKenzie, February 8, 1916. "There was a large opening in the bladder in the left wall above the ureteral opening. Through this opening a ureteral catheter was easily passed into the inguinal wound and out through the sinus opening. Both ureters were easily catheterized to the pelvis of the kidney. There was a slight ulceration on the bladder wall near the opening of the sinus into the bladder. Urine from each ureter was clear. Both ureters were working in normal manner."

For some time after the operation urotropin was administered. A permanent catheter was inserted by the urethra, with a daily irrigation of the bladder with boric acid. There was some slight discharge of serosanguinous fluid from both wounds for a number of days. One week after operation he began to have a copious discharge from the abdominal wound. On this day the permanent catheter in the urethra was removed. Two weeks and a half after operation he voided a small quantity and three weeks after the operation his daily voidance was ten ounces. The suprapubic discharge gradually diminished. The wound in the flank healed completely two weeks after operation.

PARTIAL EXCISION OF BLADDER

Upon his discharge from the hospital, March 18, he was in very good general condition and was voiding normally. Save for a brief interval some months ago, when there was a discharge of urine for several days, there has been no leakage from the suprapubic wound.

Cystoscopic Examination: November 2, 1916, by Dr. McNeill. "Cystoscope passed easily; urethra normal. Bladder mucous membrane normal except at the fundus of the bladder a little to the left of the median line, where a small scar is seen which is smooth and causes no puckering of mucous membrane and no diverticulum. Capacity of the bladder is 29 ounces. Trigone normal; ureteral openings normal in position, contour and shape; easily catheterized and urine collected from both clear."

The man has a moderate sized ventral hernia, for which he is wearing a belt, but he has refused further surgical treatment.

In a cursory review of the literature upon bladder wounds during herniotomy, one finds that in 1895, in the *ANNALS OF SURGERY*, Dr. B. Farquhar Curtis reported a considerable number of cases. Dr. Charles L. Gibson, in the *Medical Record*, March 18, 1897, added further cases, making a total of 103 cases studied, of which twenty-two were femoral. There was a mortality of 12 per cent. in this series of cases. The most recent contribution upon this subject was by Dr. W. B. DeGarmo, in the *New York State Medical Journal*, in 1913. He covered the subject very extensively and completed the literature up to the date of his publication. He summarized the various factors which would lead one to suspect the presence of the bladder in close proximity to the hernial sac as—the large veins present, the lighter yellow color of the fat, the difficulty with which the fat separates from the sac and the presence of a second, entirely free sac on the inner side of the cord.

This case was presented that it might be placed on record, and to call attention again to the possibility of this complication during herniotomy.

DR. WILLIAM A. DOWNES wondered that the accident Dr. Lee referred to does not happen a great deal more often than it does. If surgeons made a rule to expose the bladder in all direct hernias and in all large indirect hernias, by a sufficient dissection, they would be able to close their hernias much more satisfactorily to themselves and without the feeling that when they passed a suture around the neck of the sac that they may be injuring the bladder. The bladder can be exposed without the slightest difficulty in practically every case—and should be.

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DR. ALEXIS V. MOSCHCOWITZ called attention to the fact that the time of the occurrence of a urinary leakage after an operation for the radical cure of an inguinal hernia is very important. There are two methods in which such urinary leakage occurs. One way is to perforate the bladder with a needle, when sewing up the neck of the sac, or when placing the deep sutures; in these cases the urinary leakage occurs very early. The second is by tying off a small portion of the bladder; with subsequent sloughing off; in these cases the urinary leakage occurs very late.

Dr. Moschcowitz also fully agrees with Dr. Downes as regards the importance of properly separating the peritoneal sac from the bladder. He also exposes fully the bladder in all direct herniæ, and also in all larger oblique forms.

He isolates the peritoneum until the obliterated hypogastric artery is exposed; when this is exposed, and the neck of the sac is sutured or ligated at his point, it appears to him that all chances of injuring the bladder, and of a recurrence of the hernia on account of a remaining peritoneal diverticulum have been obviated.

DR. WILLIAM B. COLEY thought more heed should be paid to the properitoneal fat, which is usually a danger signal. If this were done one would avoid most injuries of the bladder. He had often spoken of it, and had himself always used great care when he had reached this thick layer of fat, not to go any further, particularly in dissecting the sac higher up or in tying off the sac. Most wounds are caused by tying the sac too high up, or in perforating with a needle. They had never met with this accident at the Hospital for Ruptured and Crippled, where over five thousand operations for hernia have been performed.

DR. NATHANIEL W. GREEN thought that a good many men make hernial repairs with rather a nebulous idea of the anatomy near the median line. They push up a certain amount of the fat towards the middle line, especially in direct hernias and in large indirect hernias; but they do not know exactly what they are doing. He had had the good luck to watch Dr. Downes in many of his hernias and the thing has cleared itself up to him very much. The procedure which he uses is to put his finger in and pull the peritoneum up tightly outward over his finger. He then pushes the bladder towards the middle line by blunt dissection, and that gets the bladder out of the way. He then opens the peritoneum downward and inward as if it were a peritoneal wound of longer dimension and starts and sews it over, and then draws it up. This procedure has cleared up the question of the bladder in the hernia wounds.

PARTIAL RESECTION OF TRANSVERSE COLON

PARTIAL RESECTION OF THE TRANSVERSE COLON FOR NON-MALIGNANT INFLAMMATORY TUMOR

DR. BURTON J. LEE presented a man, thirty-two years of age, who was admitted to New York Hospital, in the service of Dr. Charles L. Gibson, April 1, 1916. The patient had a history of chronic indigestion for about a year and a half, with increased symptoms during the last four weeks. His chief complaints were a feeling of distention in the epigastrium and of belching of gas with fairly marked constipation. Examination at that time revealed tenderness over the right lumbar region on deep pressure. There was less tenderness over the upper and middle portions of the right abdomen. No mass palpable. Physical otherwise negative. The operation was performed April 4, 1916, a right paramedian incision being used, the rectus being pulled outward. The appendix was readily delivered and was found atrophic, long and sharply kinked at the junction of the middle and proximal two-thirds—the gross lesion being therefore one of chronic appendicitis. No microscopic examination of the appendix was made. Appendectomy with cautery and inversion of stump. First purse-string Pagenstecher; second chromic catgut. Other organs apparently normal. Wound closed in tiers without drainage. The patient had an uneventful recovery and left the hospital at the end of two weeks.

He returned on April 29, his chief complaint at this time being pain in the epigastrium and rather obstinate constipation. For four days previous to admission he had had very severe cramps and there had been no movements of the bowels. Examination at this time showed a well nourished man, not looking acutely ill. Upon palpation of the abdomen, there was a distinct and rather hard mass to be felt, low down on the left side of the epigastrium. He was not especially tender upon pressure.

The abdomen was reopened May 6, 1916. Median incision above the umbilicus, all layers of the abdominal wall excepting the skin were incised down to the tumor. In the dissection an abscess cavity, containing two ounces of creamy pus, was opened into. The mass, with adherent section of abdominal wall mentioned above, was isolated and found to be intimately connected with the transverse colon. The stomach was not involved. The gross diagnosis seemed to be that of a malignant tumor of the transverse colon. Resection of the transverse colon at this point including the tumor mass. The free ends of the transverse colon were then inverted with purse-string suture of Pagenstecher. Reinforcing by second suture. Lateral anastomosis then performed, using three layers behind and two in front, outer material being Pagenstecher. Opening in mesocolon sutured with

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interrupted catgut. Closure without drainage. Through-and-through sutures of silkworm gut.

Pathological Report.—By Dr. William Elser. Specimen consisted of a section of large intestine 9 cm. in length. The wall of the intestine was for the greater part thickened to about $2\frac{1}{2}$ cm. by a hard mass attached to and incorporated in the peritoneal coat. This mass had been seared, incised from the peritoneal side, and these operations have so altered the tissues that a further gross analysis of the condition is rendered impossible. Microscopical examination showed the lesions of a productive inflammatory process. In places there was a leucocytic infiltration. A few giant cells were also found surrounding foreign bodies. It was impossible to determine the exact nature of the substances which gave rise to the formation of the foreign body giant cells, but they were not cotton, linen or silk threads. The central part of this mass contained pus which was not saved. The organism recovered from the material (wall of abscess) was a staphylococcus pyogenes aureus.

At the time of operation it was readily seen that the tumor mass did not involve the mucous membrane of the transverse colon. There was some infection of the wound which gradually lessened, with fecal discharge for about three weeks after the operation, and a persistent sinus tract for about three months. Since then the wound has remained healed.

The man has a ventral hernia, for which he refuses surgical treatment, and at times suffers somewhat from general abdominal cramps. His general condition is fair.

It is interesting to consider the possible source for this inflammatory tumor, for some infective organism may have been introduced at the time of operation, initiating the inflammatory focus. There is, of course, a possibility that this inflammatory mass in the transverse colon was present at the time the original appendectomy was done, but no proof concerning this is at hand. The resemblance of the mass to a malignant new growth, because of its firmness and infiltrating qualities and the non-involvement of the mucous membrane were additional interesting features.

The case is unique in the writer's experience and seemed worthy, therefore, of report.

DECOMPRESSIVE LAMINECTOMY FOR MULTIPLE SCLEROSIS

DR. CHAS. A. ELSBERG presented a man thirty years of age, who noticed about a year before that he was losing control of his bladder and that he was becoming constipated. Several months later he began

LAMINECTOMY FOR ADHESIVE ARACHNITIS

to feel a weakness in his legs, especially that of the left side. The legs felt stiff and would jerk in bed. The right leg became affected about one month after the left and he soon noticed that the legs were becoming numb. The patient was almost entirely bedridden for three months. When he was admitted to the Neurological Institute on the service of Dr. Peterson, he was hardly able to drag himself around with the help of two canes. There was a marked spastic paraplegia of the lower extremities with slight sensory disturbance up to the sixth dorsal level affecting entirely pain and temperature sensation. Power in the lower limbs very poor. Knee jerks markedly exaggerated. Double inexhaustible ankle clonus. Double Babinski and double Mendel. Diagnosis: Multiple sclerosis. Decompressive laminectomy was done, the arches of the 5th-8th dorsal vertebræ being removed. The cord had the typical appearance of sclerosis. The patient had been presented two months after the operation. He had improved very markedly, all evidences of spasticity had disappeared; sensation was normal all over the body; control of the bladder was much improved, the patient having only occasional incontinence at night. When presented a year and a half after the operation, he was practically well, all evidences of spasticity having disappeared, and his bladder control now being normal.

Dr. Elsberg said further that at the Neurological Institute, Dr. Pierce Bailey and he—in the course of several years—have seen a number of cases in which, to their surprise, a most remarkable improvement had followed from the operation which they called decompressive laminectomy. As there was no increase of pressure, the name "decompression" is wrong; it is simply laminectomy with exposure of the cord. They thought that the entrance of air may change pressure conditions, may have an influence upon the spinal circulation, and may have something to do with the changes that occur. In a publication some months ago, a paper presented at the American Neurological Association, they tried to give an explanation for the remarkable changes that occurred, remarkable changes in the reflexes and improvements in the patients that they had seen in a large number of cases of spinal cord disease. A real explanation they could not give, but can only state that there are a certain number of cases which are astoundingly improved by a wide laminectomy.

LAMINECTOMY FOR ADHESIVE ARACHNITIS

DR. ELSBERG presented a patient who had been operated upon two months before on account of spastic paraplegia with sensory signs up to the second dorsal level, with weakness of the bladder and constipa-

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tion. At the operation the arches of the seventh cervical and upper three dorsal vertebræ were removed. There were numerous adhesions in the arachnoid binding that membrane to the cord and to the inner surface of the dura, and forming numerous sacs filled with fluid. The adhesions were divided and the fluid liberated. The patient improved very much after the operation, the spastic paraplegia had almost entirely disappeared. Complete control of the bladder had returned and the patient was able to walk around like a normal individual.

LAMINECTOMY FOR VARICOSE VEINS OF THE CAUDA EQUINA

DR. ELSBERG presented a young woman, twenty-seven years of age, from whom a large varicose vein had been removed from between the roots of the cauda equina with almost complete relief of all the symptoms. The patient's history dated back a year and a half. She had been bedridden for a year, and had an almost complete flaccid paralysis of the lower limbs with considerable loss of control of the bladder and rectum. There was loss of all sensation over the lower three sacral areas on both sides. At the operation the arches of the 12th dorsal and upper three lumbar vertebræ were removed. Between the roots of the cauda equina there was seen an enormous varicose vein, 5 centimetres in length and at least $\frac{1}{2}$ centimetre in diameter. The walls of the vein were markedly thickened. The enlarged vein could be excised in one piece. The patient was presented six months after the operation practically well. She was able to walk around like a normal individual. The knee jerks and ankle jerks which had been absent before the operation had returned. She had regained almost complete control of the bladder and rectum.

Dr. Elsberg remarked that he had now seen a considerable number of patients with these abnormal enlarged veins within the spinal canal, and that in a number of patients the improvement after excision of the vessel had been as great as in the patient presented.

LAMINECTOMY FOR MULTIPLE EXTRAMEDULLARY SPINAL TUMORS

DR. ELSBERG presented a woman thirty-five years of age with the following interesting history: About two years before patient had begun to complain of attacks of pain in the right hypochondrium. She was suspected of having cholelithiasis and at one hospital a cholecystectomy was done. As the pain persisted, the appendix was removed by another surgeon, but without relief. For a number of months the patient had complained of peculiar sensations in the lower limbs, but little attention was paid to this. Finally she came into the hands of Dr. Abrahamson, who recognized that she had symptoms of spinal cord compression with root pains extending over the right side of the

REMOVAL OF CONGLOMERATE TUBERCLE FROM SPINAL CORD

abdomen from the sixth to ninth dorsal roots. The speaker performed a laminectomy and removed three spinal cord tumors lying under the seventh, eighth and ninth dorsal roots on the right side. The patient was at once free from her pain, but marked spasticity of the limbs required a root section, after which the patient was again able to walk around. In connection with this case, the speaker laid stress upon the importance of neurological examination in cases of patients complaining of indefinite abdominal disturbances. In not a few of these cases the abdominal symptoms have a spinal root origin. He had operated upon nine patients for spinal cord tumors or other spinal disease, upon whom previous laparotomies had been performed for supposed intra-abdominal disease. He also stated that the best results that could be obtained from posterior root section were obtained in spastic paraplegias due to old lesions of the cord either from long standing tumor or from trauma.

EXTRAMEDULLARY SPINAL CORD TUMOR IN THE UPPER CERVICAL REGION, PROJECTING INTO THE FORAMEN MAGNUM

DR. ELSBERG presented a patient who had been quadriplegic with symptoms referable to the upper cervical region. On account of an X-ray diagnosis of spondylitis operative interference had been delayed for a number of months. At the operation the laminae of the first, second and third cervical vertebrae were removed and a large extramedullary spinal tumor projecting upwards into the foramen magnum was easily removed. The patient regained considerable power in all four extremities, and was able to walk around with the help of a cane, when presented. The speaker stated that the case was unique; in the surgical literature he failed to discover the report of a tumor in this location.

LAMINECTOMY AND REMOVAL OF CONGLOMERATE TUBERCLE FROM THE SUBSTANCE OF THE SPINAL CORD

DR. ELSBERG presented a patient who had been operated upon two years before on account of loss of power in the lower extremities, bladder and rectal disturbances and severe pain in the lower abdomen. At the operation the arches of the ninth, tenth and eleventh dorsal vertebrae were removed. A small tumor measuring $1\frac{1}{2}$ by 1 centimetre was easily removed from the substance of the cord after incision. The pathological report was tuberculoma. On account of the spastic paraplegia, posterior root section was done three months later. The patient had improved markedly, had regained control of his bladder and was able to walk around without any support. There has only been one similar case reported in the literature, the case of Veraguth and Brun in which a conglomerate tubercle was removed from the substance of the cord.

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LAMINECTOMY FOR PACHYMEMINGITIS

DR. ELSBERG presented a young man who had gone through a severe sepsis with multiple foci of bone suppuration. Amputation of the thigh on the left side had been performed by Dr. Beer. About two years before he began to suffer from increasing numbness and stiffness and loss of power in the right lower limb and with stiffness of the stump of the left thigh. This gradually increased until there was complete loss of power in the remaining limb with sensory disturbances and severe pain over the mid-dorsal region. Laminectomy was performed on account of suspicion of pachymeningitis, and at the operation a large amount of granulation tissue underneath the arches of the eighth and ninth dorsal vertebræ was found with marked thickening of the dura. The granulation tissue was removed with the curette, a large amount of inflammatory tissue excised from the outer surface of the dura, and the wound drained. This resulted in a rapid disappearance of all the spastic symptoms and sensory disturbances and recovery of complete power in the remaining limb. The patient was presented free from all symptoms and able to walk like a normal individual with the aid of an artificial limb on the left side.

SUBCORTICAL SARCOMA REMOVED FROM THE PARIETAL REGION

DR. ELSBERG presented a patient of Dr. J. R. Hunt, who had been operated upon when he was in stupor. The patient had right-sided pyramidal tract symptoms, was aphasic, and had marked choking of the discs. A large osteoplastic flap was turned down over the left parietal region and the dura incised; the cortex appeared normal. When the brain was aspirated over the mid-parietal region a resistance was felt about 4 centimetres below the cortex; a small incision was made in the cortex just behind the posterior central convolution and a large encapsulated tumor, about the size of a pigeon's egg, was removed. Convalescence from the operation was uncomplicated; the eyes rapidly returned to normal; the right-sided pyramidal tract symptoms disappeared. The aphasia has been steadily improving, and now, three months after the operation, the patient is able to speak fairly distinctly, although his vocabulary is still limited. In connection with this case, the speaker made some remarks upon the diagnostic significance of passing a needle into the brain substance. The speaker has used a slightly roughened needle by means of which it is frequently possible to recognize slight differences of resistance in the brain. By this means, tumors have been discovered which would otherwise have been missed.

VOLKMANN'S ISCHÆMIC PARALYSIS

VOLKMANN'S ISCHÆMIC PARALYSIS

DR. ALFRED S. TAYLOR read a paper with the above title, for which see page 28 (January).

DR. HOWARD LILIENHAL remarked that Dr. Taylor had presented his case in a most convincing manner. Probably many patients have been operated upon who might have recovered better by physiotherapy. He still believed, however, that there are some cases of Volkmann's ischæmic contracture which will not yield to anything short of the mechanical setting right of the limb. In future his plan would be to defer operation until it had been proven conclusively that in that case at least Dr. Taylor's method could not succeed. He believed that arthrodesis of the wrist with fixation in abduction and extension is more likely to be followed by permanent improvement than by any other operation of which he knew. With the wrist stiffened in the position he described the carpal movements are not missed as much as might be expected, provided the thumb and fingers functionate well.

DR. VIRGIL P. GIBNEY said that he had done many operations for the relief of the deformity which Dr. Taylor had so accurately described, but the mechanical treatment by the Jones method had yielded him the best results. He had not tried Doctor Taylor's elastic tension but he would certainly resort to it in the future management of these distressing cases.

DR. KARL KONNELL said that the principle of regaining function by stretching scar deformities through gentle constant pull over a long period of time is one that can be advantageously applied to scar tissue wherever it is met. Certainly the lesion described by Volkmann depends chiefly for its crippling deformity on the fibrous interstitial replacement of damaged muscle bundles by scar tissue and the cure would seem logically along the lines of the paper of the evening.

He was particularly impressed by what a tiny rubber band can accomplish in stretching scar tissue, as he saw this principle applied in the war surgery of the German clinics. It seems a far cry from shattered mandible to Volkmann's contracture, yet the scar tissue in these war wounds is certainly no less resistant than in Volkmann's contracture. In contractures following injury where the symphysis of the mandible was depressed almost against the hyoid bone, he saw it again pulled out practically to its normal position by two little rubber bands pulling from rigging cemented to the upper teeth and projecting in front of the face. Also deformities wherein bodies of mandibles laid together sidewise from loss of symphysis were corrected over a period of two or three months by a little elastic band each pulling laterally.

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As applied to Volkmann's contracture this continuous stretching sounds a new note in the treatment of ischaemic contracture, enabling one eternally to pull on that scarred muscle, to stretch and absorb the scar, and elongate the muscle and to continuously take up all slack as it is created. The results presented by Dr. Taylor and the promise held forth by this method I have seen accomplished in no other way, most certainly not by operative procedures.

DR. ROYAL WHITMAN agreed with Dr. Taylor as to the principles of the treatment; that it was essentially mechanical and reconstructive, although he differed with him somewhat as to the practical details of its application. He judged from Dr. Taylor's remarks that he was not familiar with the practical application of the Jones treatment. Its purpose was to concentrate the corrective force at one point. In this deformity extension of the wrist caused flexion of the fingers and vice versa, and in several cases there was in addition contraction at the phalangeal joints. The fingers were first straightened by individual splints and fixed in the extended position. A metal splint was then adjusted to the flexed wrist and hand. This was straightened at intervals of several days until hyper-extension of the wrist was attained, usually in a comparatively short time.

It had certain mechanical advantages in severe cases over an apparatus designed to correct both contractions simultaneously. He thought Dr. Taylor rather too positive as to the limitations of treatment, since in his experience function might improve for years, indicating, apparently, regeneration of muscular tissue. He could not agree with Dr. Lilienthal as to the advantage of operative ankylosis at the wrist, because both the deformity and the contraction that induced it might be overcome by persistent treatment, while arthrodesis in childhood could not be depended on to prevent deformity.

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